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CITY OF ALEXANDRIA STREAM CLASSIFICATION STUDY

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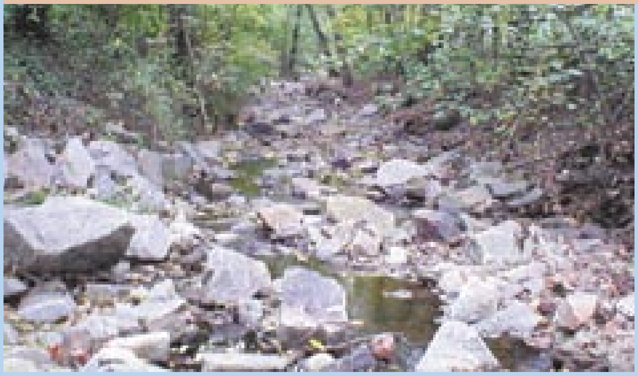

City of Alexandria Draft Stream Classification Report

April 2004

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Executive Summary

Alexandria's Environmental Management Ordinance (Article XIII) is one of the City's most visible and comprehensive water quality protection tools. Adopted by the City Council in 1992, Article XIII implements the requirements of the Virginia Chesapeake Bay Preservation Area Designation and Management Regulations (Regulations). In December 2001, the Chesapeake Bay Local Assistance Board (CBLAD) adopted significant amendments to the Regulations, which became effective in March 2002.

Among the most significant changes to the Regulations is a new requirement that a 100-foot Resource Protection Area (RPA) buffer must be designated around all "waterbodies with perennial flow." This differs from the previous requirement that protects all "tributary streams," which were defined by the Regulations as a "blue line" on a United States Geological Survey (USGS) quadrangle map.

The impact of the change on Alexandria is three-fold:

1. A determination of "water bodies with perennial flow" may result in the designation of new RPAs as well as the potential elimination of RPAs established using the previous requirement.

2. The area of land that is included within the City's RPA may change.

3. Property owners may be affected by changes in the locations of the waterways and associated RPA boundaries.

In addition to the State-mandated regulatory requirements, the City is also considering whether to enhance its ability to protect water quality by designating a 50-foot protection buffer around intermittent streams within natural channels.

To support this process, the City of Alexandria embarked on a stream classification study to establish the limits of perennial and intermittent streams within the City. During the study, field data was collected using protocols identified as suitable by the Chesapeake Bay Local Assistance Department (CBLAD). A protocol developed by Fairfax County for the same purpose was used to make the distinction between perennial and intermittent streams. A protocol developed by the North Carolina Division of Water Quality was used to make distinctions between intermittent and ephemeral streams. The Fairfax Protocol was adapted to local conditions as described in Section 4.3 of the report. Both protocols incorporate scoring methodologies for hydrologic, geomorphologic, and biological factors as they relate to a given stream's flow regime.

Work was initiated in October 2003 and completed in January 2004. The survey resulted in an RPA map that depicts the general location perennial streams and intermittent streams contained within natural channels. It is important to note that the final determination of what constitutes an RPA is established by text as provided for in

Sec. 13-105 of the City's Environmental Management Ordinance. In all cases it is the burden of the property owner to identify RPA features and to delineate boundaries in accordance with the protocol adopted by the City. In addition, it is important to recognize that this report only addresses the classification of streams into perennial, intermittent, and ephemeral categories, and does not address other requirements such as those associated with tidal and non-tidal wetlands.

The study resulted in the following changes to the City's RPA map:

- Addition of approximately 2.2 miles of RPA buffers to streams for which the RPA criteria did not apply under the previous Regulations; and,

- Removal of approximately 0.4 miles of RPA that was included in the prior Regulations.

This translates to a net increase of approximately 1.8 miles of RPA buffers to City streams. In addition, the study also resulted in the identification of 1.0 miles of intermittent streams.

This stream classification study was conducted during an extremely wet period in the City of Alexandria and the entire northern Virginia region. However, the timing of the Commonwealth of Virginia's revisions to the Regulations created a limited time window to conduct this study before adoption of changes to the Environmental Management Ordinance. In evaluating the use of the protocols described herein, the City and the consultant team exercised professional judgment designed to account for the wet conditions to the extent practicable.

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1.0 Overview of the Project

1.1 Introduction

Recently enacted changes to the Virginia Chesapeake Bay Preservation Area Designation and Management Regulations (Regulations) now require that a 100-foot Resource Protection Area (RPA) buffer must be designated around all "waterbodies with perennial flow." This differs from the previous requirement that protects all "tributary streams," which were defined by the Regulations as a "blue line" on a United States Geological Survey (USGS) quadrangle map. In addition to the State-mandated regulatory requirements, the City is also considering whether to enhance its ability to protect water quality by designating a 50-foot protection buffer around intermittent streams within natural channels.

The City of Alexandria retained the services of AMEC Earth & Environmental Inc. (AMEC), supported by Michael Baker Jr., Inc. (Baker), to assist in the evaluation of stream flow conditions within the City as necessary to identify changes in RPA designations under the new definition as well as to identify intermittent streams. This work was initiated in October 2003 and completed in January 2004 and resulted in an RPA map that depicts the general location of perennial streams and intermittent streams contained within natural channels.

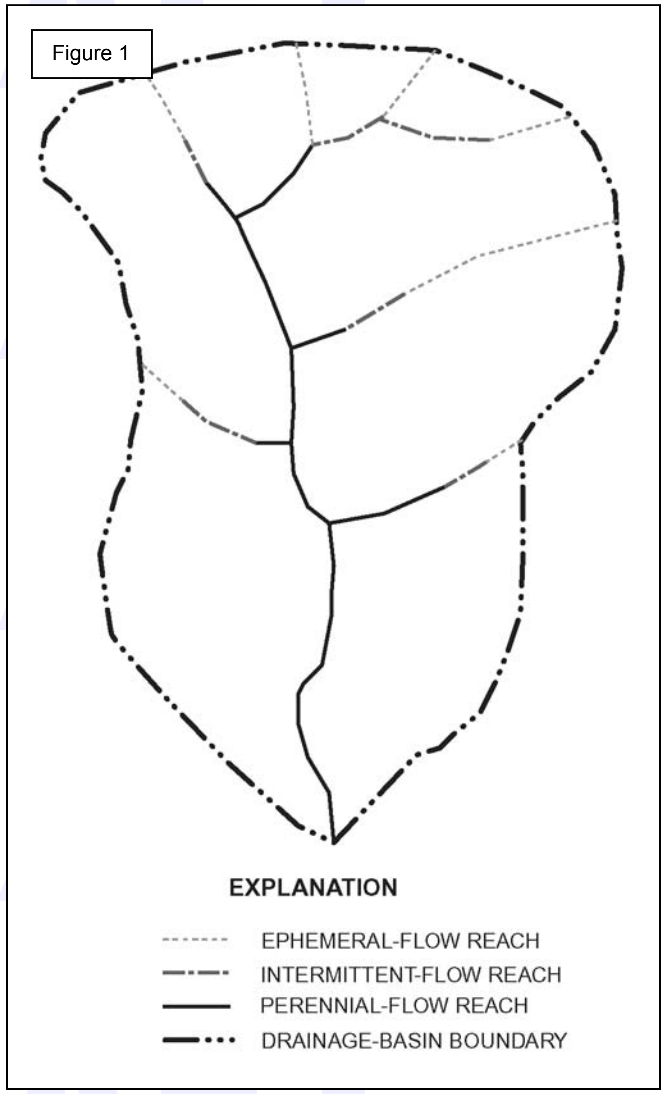
It is important to note that the final determination of what constitutes an RPA is established by text as provided for in Sec. 13-105 of the City's Environmental Management Ordinance (Article XIII). In all cases it is the burden of the property owner to identify RPA features and to delineate boundaries in accordance with the protocol adopted by the City. In addition, it is important to recognize that this report only addresses the classification of streams into perennial, intermittent, and ephemeral categories, and does not address other requirements such as those associated with tidal and non-tidal wetlands.

1.2 Alexandria's Environmental Management Ordinance

Alexandria's Environmental Management Ordinance is one of the City's most visible and comprehensive water quality protection tools. Adopted by the City Council in 1992, Article XIII implements the requirements of the Virginia Chesapeake Bay Preservation Area Designation and Management Regulations (9VAC10-20-10 et seq.). In December 2001, the Chesapeake Bay Local Assistance Board adopted significant amendments to the Regulations, which became effective in March 2002. The Board provided local governments until December 31, 2003, to revise their local ordinances to comply with the amended Regulations. Due to the significant changes in the Regulations regarding the designation of RPAs, and the City's desire to more thoroughly study the impacts of the regulatory changes, Alexandria requested and was granted an extension to June 30, 2004.

The City began the process of updating Article XIII in February 2003. The update process consisted of the development of new ordinance language and issuance of fact sheets, meetings with representatives of the Chesapeake Bay Local Assistance Department (CBLAD), meetings with the Environmental Policy Commission (EPC), two public meetings to discuss issues and options with the affected community, a work session with the Planning Commission, and the formal adoption process.

1.3 Perennial Flow Determination Protocols



Water in the environment is available in the air, in precipitation, in the ground, and on the land surface. Overland and near-surface flow contributing to stream flow is called surface and subsurface storm runoff. Stream flow derived from groundwater alone is called base flow.

When a stream receives base flow for most of the year, it is considered a perennial stream. Intermittent flow (intermittent stream) indicates a periodic or seasonal lowering of the groundwater table as base flow contributions to the stream cease. If a stream or channel does not intersect the groundwater table at any time of year and therefore only flows after rainfall or snowmelt (i.e. surface and subsurface runoff), it is considered ephemeral. Streams generally begin as ephemeral in the upper headwaters, transition to intermittent, and then become perennial (see Figure 1).

Among the most significant changes to the Regulations is the requirement that a 100-foot RPA buffer area must be established to protect all “water bodies with perennial flow,” a significant change from the previous requirement to protect all “tributary streams.” The impact of the change on Alexandria is three-fold:

1. A determination of “water bodies with perennial flow” may result in the designation of new RPAs as well as the potential elimination of RPAs established using the previous requirement.

2. The area of land that is included within the City's RPA may change.

3. Property owners may be affected by changes in the locations of the waterways and associated RPA boundaries.

The amended Regulations did not define perennial nor provide a methodology for determining perenniality. Instead, the Regulations require the use of a "scientifically valid system of in-field indicators of perennial flow." After a lengthy process, CBLAD adopted guidance regarding the definition of water bodies with perennial flow and acceptable protocols for determining perenniality. The CBLAD guidance was released on September 15, 2003. Protocols identified included field indicator methods, groundwater monitoring, surface water monitoring, drainage area based on sampling, and documented observations.

CBLAD identified two field indicator methods as suitable for making perenniality determinations. The first is a method developed by the North Carolina Division of Water Quality (Version 2.0. 1999) for making distinctions between intermittent and ephemeral streams, and later adapted for use in making distinctions between perennial and intermittent streams (herein referred to as the NC Protocol). The second is a modification of the North Carolina method developed by Fairfax County, Virginia, Department of Public Works and Environmental Services (2003) (herein referred to as the FFX Protocol). Both protocols incorporate scoring methodologies for hydrologic, geomorphologic, and biological factors as they relate to a given stream's flow regime. Documentation for both the NC Protocol and the FFX Protocol is included in the appendices.

In Northern Virginia, Fairfax County and the City of Fairfax have each applied the FFX Protocol to their respective streams to determine perenniality, and supplemented their determinations with other methods, such as surface water monitoring and documented observations, as required. The process of identifying perennial and intermittent streams within the City of Alexandria follows the approach used in Fairfax County and was adapted to local conditions for use in the City as described in Section 4.3. In addition, the NC Protocol was employed to define ephemeral streams.

2.0 Stream Classification Data Development/Collection Procedures

2.1 Base Map Development

The development of base mapping for the identification of stream reaches was key to successful field investigation. Geographic Information System (GIS) mapping data was obtained from the City, including 2-foot contour interval topographic mapping (1998), planimetric mapping, and streams, derived from aerial photography (1998), and orthorectified aerial photography (1998). This data was supplemented with other sources including data from neighboring communities and the USGS.

While the City GIS data did include stream centerlines, these stream centerlines are based on water features readily visible on aerial photography. To provide a more complete stream centerline dataset, GIS-based hydrologic analyses were performed to identify overland flow paths. The overland flow paths were analyzed to help identify streams obscured by tree cover on the aerial photography and identify areas where streams are contained in underground conveyance systems. The completed stream centerline dataset was used as core data to develop the Alexandria hydrologic dataset (AHD). The AHD was attributed to stored field data collected in subsequent field investigations.

The GIS data was compiled into base maps that included topographic and hydrologic layers, in addition to infrastructure such as roads, buildings, etc. that were used to locate sites in the field. The compiled mapping was tiled for use as field maps and mapping exhibits.

2.2. Stream Perenniality Protocol Testing and Training

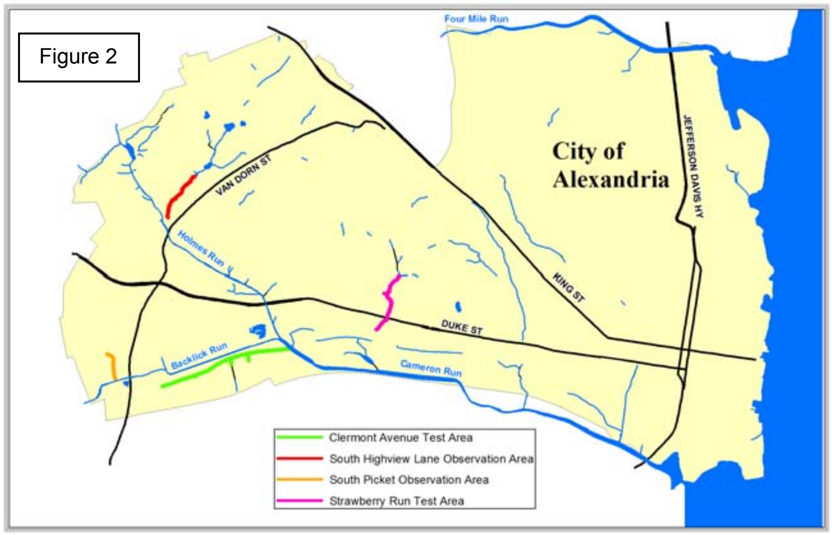
Before undertaking the field investigations to determine stream type, AMEC and Baker (the consultant team), in association with City staff, conducted stream classification protocol testing to confirm the validity of the protocols in a high-density urban environment typical of the City of Alexandria. The intent of field testing the protocols was to:

- Evaluate the utility of using sub-watershed size and topographic data from the base map overlays to estimate the potential upstream limits of perennial flow;
- Use the protocols in typical drainages in the City that would contain perennial, intermittent, and ephemeral conditions;
- Determine whether the breakpoint scores linked with each protocol applied to the streams and drainages in Alexandria;
- Establish guidance for field teams when encountering drainages that may be both underground and day-lighted (open or above ground conveyance); and
- Demonstrate protocol methodologies and interpretation of field observations for City staff.

In consultation with the City, potential locations for testing the protocols were identified on 1:200 scale base maps. Testing sites were selected along Strawberry Run and the Clermont Avenue area. These sites provided a broad range of conditions, including perennial, intermittent, and ephemeral stream reaches. In these areas, City staff had long-term knowledge of flow conditions to help validate the protocols. In addition, reconnaissance level surveys (defined as a visual assessment without implementation of the protocols) were performed in the area of South Pickett Street west of South Van Dorn Street, and in the area of South Highview Lane so that map features regarding day-lighted streams versus storm sewer (closed conveyance or underground system) could be confirmed.

The FFX and NC protocols were tested at the locations noted above on October 1, 2003 (see Figure 2). The consultant team proceeded to identify features (e.g., hydrologic, geomorphologic, or biological) that demonstrated change in the stream condition that could be potential breakpoints between perennial/intermittent/ephemeral stream reaches. Scoring was performed on representative stream reaches by examining at least 200 feet of the stream and not at single points.

Protocol testing consisted of individual specialists evaluating representative stream reaches using the proposed protocols and then discussing the results and any unique conditions encountered in the field that could affect protocol use in the City.



The field testing demonstrated that the protocols would be compatible with the stream systems that occur in Alexandria, with the exception of two primary unique conditions that were identified for evaluation during the data collection and evaluation process (as discussed in Section 2.3). These conditions were (1) the recent elevated precipitation levels and (2) the high level of modification or engineering of many channels.

Following the testing of protocols and the refinement of field procedures, training was provided for all field personnel. A training manual and field data forms were prepared to meet the needs of the City for the identification of perennial and intermittent streams. Both classroom and in-field instruction were provided so that field personnel consistently applied the protocols and field procedures, thus providing a measure of quality control for the field data to be collected in a consistent and repeatable manner.

Both protocols incorporate scoring methodologies for hydrologic, geomorphologic, and biological factors as they relate to a given stream's flow regime. Documentation for both the NC Protocol and the FFX Protocol is included as appendices to this report.

2.3 Data Collection and Processing

The field data collection effort was conducted during several periods by teams, each consisting of two trained field staff. The initial assessment took place in October 2003 during which two teams collected FFX and NC protocol parameters along stream reaches throughout the City over a period of seven days. In the initial assessment, both teams encountered a number of stream sections that contained partially or completely engineered channels. These engineered channels were not initially assessed, but were identified on the field maps and photographed at the upstream and downstream ends. A second period of fieldwork was conducted in November 2003 to assess additional stream segments identified by City staff based on field knowledge.

A third phase of data collection was conducted in January 2004 in order to assess reaches where access issues had been encountered and to assess the partially or totally engineered streams not originally assessed. The engineered reaches were assessed by completing as many sections of the FFX Protocol as possible. For some reaches, the channels were completely engineered (i.e., concrete bed and bank) and only the hydrology section of the FFX Protocol could be completed.

Throughout the field data collection process, a quality assurance and quality control (QA/QC) process was conducted on the compiled data. Where appropriate, a team revisited streams to ensure the accuracy of the protocol scores.

The AHD dataset was attributed throughout the data collection process with the field-collected data and each reach was classified into perennial, intermittent, or ephemeral. In cases where changes in classification were unexpected, such as an upstream reach scoring as perennial based on the FFX Protocol, a middle stream reach scoring as intermittent, and a downstream reach scoring as perennial, a follow-up field visit was performed in the third phase of the field data collection to independently validate the protocol scoring.

3.0 Hydroclimatic Conditions During Data Collection

3.1 Field Weather Conditions

Both the FFX and NC protocols were developed for use throughout the year. Key to proper use of these protocols is that field data collection should take place no sooner than 48 hours after the last rainfall so both surface and subsurface runoff from the rainfall event has been conveyed downstream and the stream, if perennial, has returned to base flow conditions. If the stream is intermittent, the stream will return to a base flow condition in the wet season and cease to flow in the dry season. If the stream is ephemeral, it will cease to flow.

Field work was interrupted only once during the data collection effort due to a rain event that ended on October 15, 2003. The gauge at Washington National Airport recorded 1.21 inches of rainfall during that event and fieldwork resumed on October 17, 2003. Based on the above, weather conditions during the field visits were appropriate for data collection.

3.1.1 Groundwater Conditions

As noted previously, groundwater is the source of base flow for both perennial and intermittent streams. Rainfall and snowmelt percolate through the soil zone and enter the groundwater system. Much of this recharge moves slowly through an aquifer and is discharged to streams.

At Washington National Airport, precipitation was recorded on 146 days in 2003, or approximately 40% of the year, resulting in one of northern Virginia's wettest years on record. Approximately 70% of these rainfall events resulted in less than 0.5 inches of precipitation. Rainfall from these events contributed significantly to the recharge of the groundwater table. It should also be noted that this wet period was preceded by four years of drought.

Movement through groundwater is slow compared to surface water travel. While surface water may travel in feet per second, common rates of groundwater flow are in the foot/day, foot/month, or even foot/year range (see Figure 3). A recent USGS study found that the age of groundwater in shallow aquifers in the Chesapeake Bay watershed ranges from modern (less than 1 year) to more than 50 years, with a median age of 10 years. However, because of insufficient data, an assessment of the residence time in the Coastal Plain Lowland hydrogeomorphic region, which includes the City of Alexandria, was not performed.

The consultant team performed an assessment to determine if local precipitation had direct effects on local groundwater levels. No active groundwater monitoring wells exist in the City of Alexandria; however, the USGS maintains two groundwater monitoring wells in the immediate region, one at Arlington Cemetery, Arlington County (Well No. 54V 3), and the other at the USGS National Center in Reston, Fairfax County (Well No. 52V 2). Of these two locations, the monitoring well in Arlington Cemetery is the closest to the City of Alexandria. From a visual review of the data from this monitoring well, it is evident that groundwater levels do not respond immediately to a given rainfall event, but instead respond to rainfall trends, with groundwater levels rising gradually over several months.

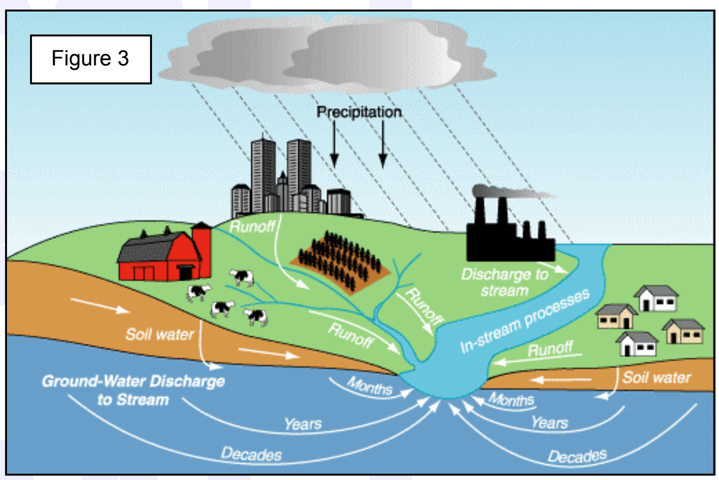


Figure 3

Based on data collected for the USGS monitoring well at Arlington Cemetery from 1958 through 2003, the long-term average groundwater level is 42.78 feet below ground level. A new record high groundwater level of 39.9 feet below ground level was recorded on July 24, 2003. The next groundwater level observation was on October 14, 2003, in which groundwater levels dropped to 40.35 feet below ground level, a decrease of 0.45 feet.

The evidence presented above suggests that high precipitation amounts in the months preceding the field work raised groundwater levels, which may have impacted the stream classification breakpoint locations identified during the field work. Because the City felt that it was important to make an assessment of perennial streams before adopting a revised Environmental Management Ordinance, this impact was unavoidable. However, it should be noted that the protocols purposefully include factors that are not immediately affected by short-term changes in hydrology such as geomorphology and stream vegetation. With any dynamic ecosystem, factors may change; therefore, the Environmental Management Ordinance provides an opportunity for a reassessment at a later time. The ultimate determination of perenniality will be made in accordance with the Environmental Management Ordinance and based on the City's assessment of all relevant field data presented.

3.1.2 Extreme Events

Extreme weather events can dramatically affect the amount of surface water runoff within a watershed. Likewise, the intensity, duration, and frequency of events can influence the elevation of groundwater within the watershed and ultimately the elevation along the subsurface gradient where groundwater discharge, in the form of seeps/springs or streambed discharge, occurs.

On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast, with its huge wind field piling water up into the southern Chesapeake Bay. While Alexandria received only 2.28 inches of precipitation, in many places Isabel's storm surge was higher than the previous record storm known as the Chesapeake-Potomac Hurricane of 1933. In Alexandria, the water level in Old Town reached 9.5 feet above mean sea level. Numerous businesses, including the City's marinas, were flooded. Winds also knocked trees down around the city and storm surge water flooded the employee parking lot of Washington National Airport.

While this major event contributed significantly to surface runoff, these storms had much less impact on groundwater levels.

4.0 Data Collection/Results

Eighty-seven stream reaches were identified for field/alternative study as a result of the data collection process and approximately 27.71 miles of City streams were classified. A stream reach was defined as a representative stream section, typically at least 200 feet in length, that the field teams evaluated using the appropriate field protocol. The majority of stream sections investigated consisted of one reach. Those stream sections with multiple reaches exhibited condition changes that were predominantly influenced by manmade structures. More than half of the assessed reaches originated from either a road culvert or a storm drain outfall at the upstream end and roughly a quarter of them terminated in a road culvert or a storm drain inlet at the downstream end. In addition, geomorphologic scores and vegetation/biotic scores were almost uniformly low. The consultant team observed a relatively small number of perennial/intermittent and intermittent/ephemeral interfaces, apparently a result of the high number of City streams that are piped.

4.1 Standard Field Determinations

Field data collection teams physically examined a total of 13.9 miles of the City's streams and visited over 80 sites. Of those sites walked and assessed using the FFX and NC protocols, approximately 7.6 miles of stream were classified as perennial, 1.0 miles as intermittent, and 1.7 miles as ephemeral. An additional 3.6 miles of stream were re-examined as described in Section 4.3 below.

A major component of the employed protocols deal with the flow of water and/or the presence of groundwater seeps/springs in a given reach. Most of the perennial stream flow in highly urbanized areas such as Alexandria comes from groundwater seeps and/or springs in the stream banks and surrounding floodplain. In a highly urban condition, rainfall runoff typically discharges to the streambed more quickly due to the increase in imperviousness and the fact that historic stormwater management controls result in runoff being collected and conveyed directly to a stream channel rather than allowing for natural infiltration and re-nourishment of groundwater supplies.

In many instances, stream reach scoring was affected by manmade alterations (e.g., channelization, engineered channels, rip-rap, etc.) along with the City's dense urban conditions. For example, in partially engineered channels known to have perennial flows based on City staff field knowledge, scores as low as 15 on the NC Protocol were reported.

In addition, biological factors received relatively low scores related to seasonal die-off of many hydrophytic species, and a general lack of benthic macroinvertebrates (even from areas that scored perennial). Most of the reaches exhibited low benthic macroinvertebrate scores. Very few mayfly, stonefly, or caddisfly biota (EPT taxa- *Ephemeroptera*, *Plecoptera*, and *Trichoptera*), all considered highly intolerant of poor water quality conditions, were found in any of the streams. Most of the benthic organisms found were pollution tolerant varieties such as crayfish (*Decapoda*), pouch snails (*Gastropoda*), and aquatic worms (*Oligochaeta*).

The scores for vegetation were also relatively low. Field teams observed Periphyton (green algae) in some of the streams while they observed almost no rooted aquatic plants. The only vegetation parameter to score well consistently was iron-oxidizing bacteria/fungus, a characteristic commonly associated with the discharge of groundwater from seeps or discharge into or near the streambed. Many of the reaches had low geomorphology scores. Many stream reaches demonstrated observable effects typically associated with development impacts ranging from partially or totally engineered channels to severely incised channels resulting in low sinuosity, to lack of clearly defined bank full benches and decreased occurrence of natural levees.

Although few stream sections had multiple reaches, there were some features consistent with the perennial/intermittent and intermittent/ephemeral interfaces. Of the sections with reach breaks, the dominant features were storm drain outfalls, culverts, and manmade ponds. There were a smaller number of natural break points and they occurred at headcuts and confluences with tributaries.

4.2 Non-Field Determinations

The consultant team, in conjunction with City staff, made non-field stream classification determinations based on aerial photos, topography, local knowledge of City staff, and other observable data, typically in cases where access to a particular stream reach was not readily available. Other examples of non-field stream classification determination included stream reaches that were identified in the office after the field work was conducted, were highly impacted by armoring, or needed a quality assurance check. In addition, several of the City's larger streams and tributaries were not field evaluated due to the presence of readily available data and other methodologies for determining perenniality. These streams included sections of Cameron Run, Four Mile Run, Hooffs Run, Backlick Run, and Holmes Run, as described below.

4.2.1 Streams That Have Flow Data and Related Information

Inside the City limits, both Cameron Run and Four Mile Run have had stream gauge stations in place for a significant period of time. Cameron Run (USGS Gauging Station No. 01653000 Cameron Run at Alexandria, VA) has been gauged continuously since June 1, 1955. From that gauge, the lowest recorded flow in Cameron Run is 1 cubic foot per second (cfs). This lowest recorded flow was measured during August 2002, when Virginia was nearing the end of a 4-year drought. Four Mile Run (USGS Gauging Station No. 01652500 Four Mile Run at Alexandria, VA) has been gauged since October 1, 1951. However, gauging operations on Four Mile Run have not been continuous, with breaks in the gauging operations from September 30, 1969 to September 28, 1973; from September 30, 1975 to July 1, 1979; from December 15, 1982 to October 1, 1998; and from September 30, 1999 through October 1, 2000. The minimum flow recorded at this gauging station is 0.7 cfs on multiple days during August 1957. During the most recent drought (1998-2002), the minimum recorded flow was 1.2 cfs. The evidence of uninterrupted flow at these two gauging stations is sufficient to deem these streams perennial in accordance with the definition provided in the CBLAD guidance.

4.2.2 Determinations Made Based on Supporting Data

Areas that are protected under the Chesapeake Bay Preservation Area Designation and Management Regulations include tidal wetlands. Based on a review of the Virginia Institute of Marine Science, Center for Coastal Management, Tidal Marsh Inventory, areas of tidal wetlands are found along Hooffs Run and its unnamed tributary. The wetlands are classified as Type XI, Freshwater Mixed Community.

Based on this data and the requirements of the Regulation, no further classification of Hooffs Run and its un-named tributary using the FFX Protocol is required.

4.2.3 Determinations Made by Others

Fairfax County initiated a stream assessment study in 2003 that included perenniality classifications for each of its stream reaches. During the Fairfax County assessment field work (March through October, 2002), the County used the FFX Protocol to classify its streams. Both Backlick Run and Holmes Run originate in Fairfax County and flow through Alexandria to form Cameron Run. Fairfax County has classified both Backlick Run and Holmes Run as perennial streams and has established RPAs on each. Since these streams flow through Alexandria accumulating additional drainage area and flow, there is no logical reason to think that the perennial nature of these waterways would change downstream on reaches within the City limits.

In addition, Holmes Run is also influenced by Lake Barcroft, a manmade lake that was originally constructed as a water supply reservoir for the City of Alexandria, but was sold in 1950 when it became too small to adequately provide water for the City. Lake Barcroft is situated along Holmes Run just upstream of the City of Alexandria and is managed by the Lake Barcroft Watershed Improvement District (LBWID).

The dam at Lake Barcroft, like all dams, has some leakage. The LBWID installed a weir to monitor dry weather leakage from the lake. The LBWID estimated that the dry weather leakage from the dam averages approximately 1.1 cfs, thus providing continuous base flow for Holmes Run.

4.3 Urban Impact/Flow Determinations

As stated earlier, both Fairfax County and the City of Fairfax have applied the FFX Protocol to determine perenniality, and have supplemented determinations with other methods as required. The following paragraphs discuss stream reaches in the City of Alexandria where perenniality was determined using alternative methods.

CBLAD approved the use of either the FFX and/or NC protocols for local jurisdictions, along with other tools such as groundwater or surface water monitoring, or using photographs of areas to demonstrate water bodies with perennial flow. CBLAD also acknowledged that local jurisdictions should evaluate the use of the protocols for use in specific areas given the diversity of geology and development patterns within Tidewater Virginia communities. A documented approach allows practitioners to provide consistent and reproducible results and allows local jurisdictions to make adjustments to the threshold values based on local conditions.

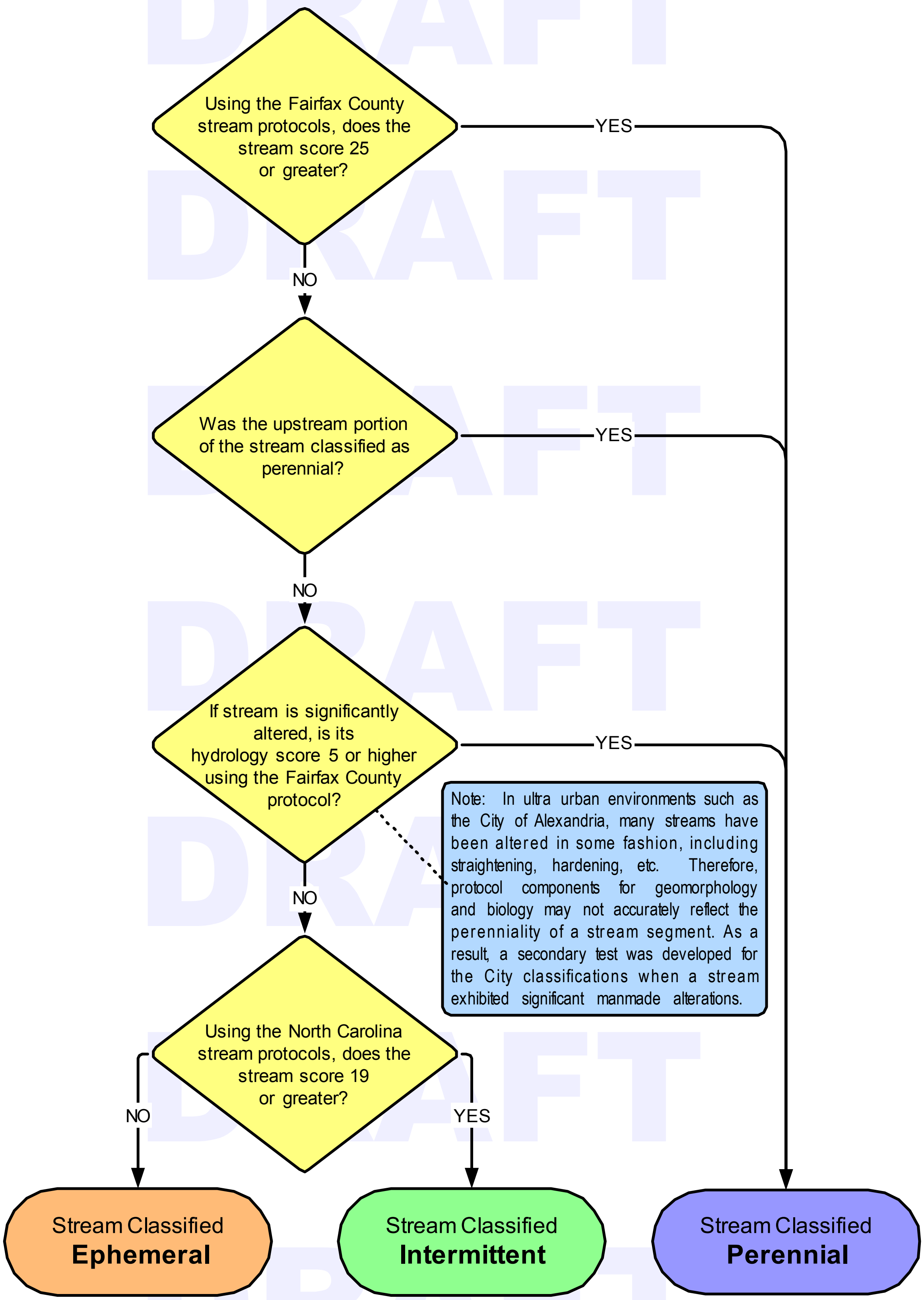
After reviewing the field data sheets, it was determined that a number of stream reaches with high hydrology scores on the FFX Protocol were not classified as perennial. Almost all of these reaches exhibited some kind of significant urban alteration, such as engineered channels. The consultant team discussed this issue with City staff, who requested that the field data be analyzed to determine what was causing these reaches with consistent flow to score lower than 25 points on the FFX Protocol.

In many cases, these reaches had undergone artificial straightening and armoring (typically rip-rap, but also concrete, brick, and corrugated metal). A review of the field data showed that the reaches classified as perennial by the FFX Protocol all had hydrology scores of at least 5 points. Therefore, a FFX Protocol hydrology score of 5 or more was proposed as the criteria to classify a reach as perennial when significant urban impacts were present in the stream system and the overall FFX Protocol score was less than 25 points (see decision matrix in Figure 4).

The FFX Protocol hydrology score of 5 points was used as the limiting parameter in the decision matrix for several reasons. All of the reaches that were initially classified as perennial using the FFX Protocol had hydrology scores of at least 5 points and the mean hydrology score for those reaches was 7.0. The mean hydrology score for the altered reaches was 5.8. The altered reaches that had hydrology scores of 5 or more had significantly higher scores for streambed soils and hydrophytic vegetation than the reaches with hydrology scores below 5. These two parameters are indicators of the long-term presence of water in the channel. The altered reaches with hydrology scores of 5 or more also had much higher scores on parameters for organisms that rely on consistent flow, such as benthic macroinvertebrates, fish, and amphibians. These results help support the use of the FFX Protocol hydrology score in the decision matrix.

Application of this methodology resulted in an additional 3.6 miles of stream being classified as perennial (a total of 22 stream reaches).

Figure 4 – Stream Classification Decision Matrix



Of the 30 reaches that were not classified as perennial, 11 scored 19 or more points on the NC Protocol and were classified as intermittent, and 17 scored less than 19 and were classified as ephemeral. The final two reaches were identified in the office and classified as ephemeral based on City staff field observations. Table 4.1 summarizes the assessed reaches by their numerical identifier, their FFX and NC Protocol scores, and their FFX Protocol hydrology scores. More detailed information on the scores is provided in the appendix.

5.0 Conclusion

The City of Alexandria's stream classification project was designed to classify the City's waterways in support of the City's revised Environmental Management Ordinance. Under amended State Regulations, waterbodies with perennial flow must be protected by a 100-foot RPA buffer. Based on the results of the stream classification study, the City will add approximately 2.2 miles of RPA buffers to streams for which the RPA criteria did not apply under the previous Regulations. Conversely, the City will lose approximately 0.4 miles of RPA that was included in the prior Regulations. The City adds a net of approximately 1.8 miles of RPA buffer to its streams as a result. The resulting general RPA map depicts all of the changes based on the results of this study. It is noted that for areas on the general map where RPA designations have not changed, the RPA widths/boundaries might be different because higher resolution mapping data was used to create the new general map.

In addition to these new perennial stream designations, the classification study also identified 1.0 miles of intermittent stream that are proposed to be protected by a 50-foot vegetated buffer area.

The City of Alexandria and the consultant team acknowledge that this stream classification study was conducted during an extremely wet period in the City of Alexandria and the entire northern Virginia region. The year 2003 neared or broke many regional rainfall records dating back over 100 years. However, the timing of the Commonwealth of Virginia's revisions to the Regulations created a limited time window in which to conduct this study. In evaluating the use of the protocols described herein, the City and the consultant team exercised professional judgment designed to account for the wet conditions to the extent practicable.

Changes to the RPA map were generated by the data captured during this project and represent a reasonable approach to new regulatory requirements. It should be noted that the City's RPA map is designed to be a guide for both the City staff and citizens. The City's Environmental Management Ordinance continues to require that for any proposed development in or near an RPA, an environmental site assessment must be performed that clearly delineates the individual components of the RPA as well as the total geographic extent of the RPA as defined using a methodology approved by the City.

Table 1 – Stream Classification by Reach with Protocol Scores

Perennial based on Full Fairfax Protocol		Perennial based on Fairfax Hydrology Score 5 or Higher				Intermittent			Ephemeral	
Reach ID	Fairfax Protocol Score	Reach ID	Fairfax Protocol Score	Fairfax Hydrology Score	NC Protocol Score	Reach ID	Fairfax Protocol Score	NC Protocol Score	Reach ID	NC Protocol Score
1.01	32	**7.01**	15	6	21	**4.01**	12.5	20	**3.01**	13.5
2.01	31.5	**8.01**	18	6.5		**5.02**	18.5	26	**11.01**	15
5.01	26.5	**9.01**	14	5	20	**24.01**	13	19	**14.01**	2.5
9.02	30	**9.05**		5.5		**30.03**	21.5	25.5	**15.01**	2.5
10.01	27.5	**21.02**	20.5	8	22	**38.02**	See notes.		**18.01**	11.5
12.01	31.5	**23.03**		7		**38.03**	17	22	**19.01**	4
13.02	26.5	**23.04**	See notes.			**38.05**	19	25	**20.02**	9
16.01	26	**30.02**	23	5.5		**40.01**	15	20	**23.01**	5
19.02	29	**30.04**	19	5		**40.02**	16.5	23.5	**34.01**	17
19.03	27	**33.02**	24.5	5.5		**53.01**	19.5	23	**35.01**	11.5
19.04	30	**42.01**	15.5	5.5	20.5	**76.01**	17	19.25	**39.01**	12.5
20.01	26	**49.01**	20	5.5	19.5				**51.01**	17.5
21.01	31	**60.01**	22	6	24				**52.01**	9.5
22.01	31	**60.02**	23.5	7	23				**52.02**	17.5
22.02	See notes.	**65.01**	19	5	19				**54.02**	14
22.03	See notes.	**66.01**	20	6	22.5				**55.01**	10.5
23.02	27.5	**67.02**	22.5	5	20.5				**61.01**	14
25.01	27.5	**67.03**	24.5	5	22				**67.06**	See notes.
26.01	35	**70.01**	15	5	26				**67.07**	See notes.
28.01	28.5	**71.01**	17.5	6	26					
30.01	36									
32.01	26.5									
33.01	30.5									
33.03	29.5									
38.01	31									
38.04	29.5									
39.02	29									
50.01	25.5									
54.01	27.5									
62.01	26									
64.01	25.5									
66.02	38.5									
67.01	39									
67.04	25									
67.05	29									
69.01	29									
79.01	26									

Notes:
22.02 - Designated perennial based on upstream reach's (22.01) perennial designation.
22.03 - Designated perennial based on original RPA map and because segment is almost entirely enclosed in main stem RPA
23.04 - Engineered channel; designated perennial based on upstream reach's (23.03) perennial designation.
38.02 - Engineered channel; designated intermittent based on upstream reach's (38.03) intermittent designation.
67.06 - Not found in field. Identified by City based on topography, and designated ephemeral.
67.07 - Not found in field. Identified by City based on topography, and designated ephemeral.

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NWS. National Weather Service Forecast Office, Baltimore/Washington. Past Weather Data http://www.erh.noaa.gov/erl/lwx/climate.htm.

APPENDICES

Appendix A – Data Summary Tables

Scores by Reach Using Fairfax County Protocol

Site ID	Total Score	Presence or Absence of Flowing Water	Presence of High Groundwater Table	Leaflitter in Streambed	Drift Lines	Sediment on Debris or Plants	Total Hydrology Score	Riffle-pool Sequence	Substrate Sorting	Natural Levees	Sinuosity	Active or Relic Floodplain	Braided Channel	Recent Alluvial Deposits	Bankfull Bench Present	Continuous Bed and Bank	2nd Order of Greater Channel Present	Total Geomorphology Score	Redoximorphic Features in Sides of Channel or Headcut	Chroma	Total Streambed Soils Score	Rooted Aquatic Plants in Streambed	Presence of Periphyton/Green Algae	Iron Oxidizing Bacteria/Fungus	Wetland Plants in Streambed	Total Vegetation Score	Benthic Macroinvertebrates	Bivalves	EPT Taxa	Total Macroinvertebrate Score	Fish	Amphibians	Total Vertebrate Score
1.01	32	3	2	0.5	1	1.5	8	1	1	0	1	2	0	3	2	3	0	13	1.5	3	4.5	2	0	1	1.5	4.5	0.5	0	0	0.5	1.5	0	1.5
2.01	31.5	3	2	0.5	1.5	1.5	8.5	0	0	1	1	1	0	3	2	3	0	11	1.5	3	4.5	2	3	0	1.5	6.5	0	0	0	0	0.5	0.5	1
4.01	12.5	0	0	1	0.5	0	1.5	2	3	0	1	0	0	1	1	3	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.01	26.5	3	1	1	1.5	0	6.5	3	3	0	2	0	0	3	2	3	0	16	0	3	3	0	0	0.5	0	0.5	0.5	0	0	0.5	0	0	0
5.02	18.5	0	0	0.5	1.5	0.5	2.5	2	3	1	2	1	0	3	2	2	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.01	15	3	0	0	1.5	1.5	6	2	1	0	0	1	0	0	1	1	0	6	1.5	0	1.5	0	0	0	0	0	0	0	0	0	1.5	0	1.5
8.01	18	3	0	1	1.5	1	6.5	0	0	0	0	0	0	2	2	3	0	7	0	0	0	0	3	1.5	0	4.5	0	0	0	0	0	0	0
9.01	14	3	0	1	0.5	0.5	5	1	2	0	0	0	0	1	1	3	0	8	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
9.02	30	3	0	1.5	1.5	0.5	6.5	3	3	0	2	3	1	3	2	3	0	20	1.5	0	1.5	0	0	0	0	0	0.5	0	0	0.5	1.5	0	1.5
9.05	5.5	3	0	1.5	0.5	0.5	5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.01	27.5	2	0	0.5	1.5	1	5	1	2	0	1	1	2	3	3	3	0	16	0	3	3	1	0	0	0	1	1	0	0	1	1.5	0	1.5
12.01	31.5	3	3	0.5	1.5	1.5	9.5	2	3	1	2	1	0	1	3	3	0	16	1.5	3	4.5	0	0	1.5	0	1.5	0	0	0	0	0	0	0
13.02	26.5	2	2	1	1.5	1	7.5	1	3	0	2	1	1	3	1	1	0	13	1.5	3	4.5	0	0	1.5	0	1.5	0	0	0	0	0	0	0
16.01	26	3	2	1	0.5	1	7.5	3	2	0	2	1	0	3	1	2	0	14	0	3	3	0	0	1.5	0	1.5	0	0	0	0	0	0	0
19.02	29	3	2	1	0.5	0.5	7	3	2	1	2	2	0	3	1	2	0	16	1.5	3	4.5	0	0	1.5	0	1.5	0	0	0	0	0	0	0
19.03	27	3	2	0.5	1	0.5	7	3	2	0	2	1	0	2	1	3	0	14	0	3	3	0	0	1	1	2	1	0	0	1	0	0	0
19.04	30	3	2	0.5	1	0.5	7	3	2	0	2	1	0	2	1	3	3	17	0	3	3	0	0	1	1	2	1	0	0	1	0	0	0
20.01	26	3	3	0.5	1	1	8.5	2	1	0	3	1	1	1	2	1	0	12	1.5	3	4.5	0	0	0	0	0	0	0	0	0	0	1	1
21.01	31	3	2	1	0.5	1	7.5	3	2	1	3	2	0	1	2	2	0	16	1.5	3	4.5	0	0	1	0	1	0	0	0	0	1	1	2
21.02	20.5	3	3	1.5	0	0.5	8	0	0	0	1	2	2	1	0	1	0	7	1.5	3	4.5	0	0	1	0	1	0	0	0	0	0	0	0
22.01	31	3	2	1	0.5	1	7.5	3	3	1	3	3	0	1	2	2	0	18	1.5	3	4.5	0	0	0	0	0	0	0	0	0	0	1	1
23.02	27.5	3	1	0.5	1	0.5	6	2	3	0	2	0	0	2	1	2	0	12	1.5	3	4.5	0	2	0.5	0.5	3	1	0	0	1	0	1	1
23.03	7	3	2	1.5	0	0.5	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.01	13	0	1	0.5	1	0.5	3	1	2	0	1	2	0	1	0	2	0	9	0	0	0	0	0	0.5	0.5	1	0	0	0	0	0	0	0
25.01	27.5	2	2	1	1.5	1	7.5	1	1	0	2	3	0	2	1	1	3	14	1.5	3	4.5	0	0	1	0.5	1.5	0	0	0	0	0	0	0
26.01	35	3	2	1	1	0.5	7.5	3	3	0	2	2	0	2	2	2	3	19	1.5	2	3.5	0	0	1.5	1	2.5	1	0	0	1	0	1.5	1.5
28.01	28.5	2	1	1	1	1	6	3	3	0	2	1	0	2	1	2	0	14	0	0	0	0	3	0.5	1	4.5	1	0	3	4	0	0	0
30.01	36	3	2	1	1	0.5	7.5	3	3	0	2	2	0	3	2	3	3	21	1.5	3	4.5	0	2	0.5	0	2.5	0.5	0	0	0.5	0	0	0
30.03	21.5	3	0	0.5	0.5	0.5	4.5	2	2	0	2	1	0	1	2	3	0	13	0	3	3	0	0	1	0	1	0	0	0	0	0	0	0
30.04	19	2	1	0.5	0.5	1	5	1	1	0	0	2	0	1	0	1	0	6	1.5	3	4.5	0	2	1	0	3	0.5	0	0	0.5	0	0	0
32.01	26.5	3	1	1	1.5	1	7.5	3	2	0	2	1	0	2	2	3	0	15	0	0	0	0	1	1.5	1	3.5	0.5	0	0	0.5	0	0	0
33.01	30.5	3	2	1	0.5	1	7.5	3	2	0	2	0	0	2	1	3	3	16	1.5	3	4.5	0	0	1	0	1	1.5	0	0	1.5	0	0	0

Scores by Reach Using Fairfax County Protocol

Site ID	Total Score	Presence or Absence of Flowing Water	Presence of High Groundwater Table	Leaflitter in Streambed	Drift Lines	Sediment on Debris or Plants	Total Hydrology Score	Riffle-pool Sequence	Substrate Sorting	Natural Levees	Sinuosity	Active or Relic Floodplain	Braided Channel	Recent Alluvial Deposits	Bankfull Bench Present	Continuous Bed and Bank	2nd Order of Greater Channel Present	Total Geomorphology Score	Redoximorphic Features in Sides of Channel or Headcut	Chroma	Total Streambed Soils Score	Rooted Aquatic Plants in Streambed	Presence of Periphyton/Green Algae	Iron Oxidizing Bacteria/Fungus	Wetland Plants in Streambed	Total Vegetation Score	Benthic Macroinvertebrates	Bivalves	EPT Taxa	Total Macroinvertebrate Score	Fish	Amphibians	Total Vertebrate Score
33.02	24.5	3	0	1.5	0.5	0.5	5.5	2	3	0	1	1	2	1	1	3	0	14	0	0	0	0	0	0.5	0	0.5	1.5	0	3	4.5	0	0	0
33.03	29.5	3	2	1	1	1	8	2	3	1	2	2	0	1	1	3	3	18	0	0	0	0	2	1	0.5	3.5	0	0	0	0	0	0	0
34.01	10.5	0	1	1	1	0.5	3.5	1	3	0	1	0	0	1	0	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38.01	31	3	2	1	1	0.5	7.5	3	3	0	2	2	0	2	2	3	0	17	1.5	2	3.5	0	0	1.5	1	2.5	0.5	0	0	0.5	0	0	0
38.03	17	1	1	0.5	0.5	0.5	3.5	1	1	0	1	1	0	1	2	2	0	9	0	3	3	0	0	1	0.5	1.5	0	0	0	0	0	0	0
38.04	29.5	3	1	0.5	1.5	1.5	7.5	2	3	0	2	2	1	2	2	3	0	17	0	2	2	0	0	1.5	0.5	2	1	0	0	1	0	0	0
38.05	19	1	2	0.5	0.5	0.5	4.5	2	2	0	1	2	0	1	1	2	0	11	0	1	1	0	0	1.5	0.5	2	0.5	0	0	0.5	0	0	0
39.02	29	3	2	1	0.5	1	7.5	3	3	0	2	1	0	1	2	3	0	15	0	3	3	0	0	1.5	1	2.5	0.5	0	0	0.5	0	0.5	0.5
40.01	15	0	1	1	1	0.5	3.5	0	2	0	1	2	1	2	1	2	0	11	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0
40.02	16.5	0	2	1	1	0.5	4.5	1	2	0	1	1	0	1	2	2	0	10	0	1	1	0	0	0.5	0.5	1	0	0	0	0	0	0	0
42.01	15.5	3	0	1.5	0.5	0.5	5.5	2	2	0	1	0	1	0	1	3	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.01	20	3	0	1.5	1	0	5.5	1	2	0	0	2	1	2	0	3	0	11	0	3	3	0	0	0	0	0	0.5	0	0	0.5	0	0	0
50.01	25.5	3	0	1	1.5	0	5.5	2	2	2	1	3	1	2	2	3	0	18	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1
51.01	15.5	0	0	1	1	0	2	2	2	0	1	2	1	1	0	3	0	12	1.5	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0
52.02	15.5	0	0	1	1.5	0	2.5	0	3	0	0	1	1	2	0	3	0	10	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0
53.01	19.5	3	0	0.5	0.5	0.5	4.5	2	1	0	2	1	0	2	2	3	0	13	1.5	0	1.5	0	0	0.5	0	0.5	0	0	0	0	0	0	0
54.01	27.5	3	0	0.5	1.5	1	6	3	3	0	2	3	1	1	2	3	0	18	1.5	1	2.5	0	0	0	0	0	1	0	0	1	0	0	0
54.02	10	0	0	0.5	0	0	0.5	0	0	0	2	2	0	0	1	3	0	8	1.5	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0
55.01	9.5	0	0	0	1	1	2	0	0	0	1	0	2	1	0	1	0	5	1.5	1	2.5	0	0	0	0	0	0	0	0	0	0	0	0
60.01	22	3	0	1.5	1.5	0	6	0	2	0	1	2	0	2	0	3	0	10	1.5	3	4.5	0	1	0	0	1	0.5	0	0	0.5	0	0	0
60.02	23.5	3	0	1.5	1.5	1	7	2	3	0	2	0	1	2	1	3	0	14	1.5	0	1.5	0	0	0.5	0	0.5	0	0	0	0	0.5	0	0.5
62.01	26	3	0	1.5	1.5	0.5	6.5	2	3	0	0	1	1	2	1	3	0	13	0	3	3	0	2	0.5	0	2.5	0	0	0	0	1	0	1
64.01	25.5	3	0	0.5	1.5	0.5	5.5	1	3	0	3	2	0	1	1	3	0	14	1.5	1	2.5	0	2	1	0	3	0	0	0	0	0	0.5	0.5
65.01	19	3	0	0.5	1.5	0	5	2	2	0	0	0	1	2	1	3	0	11	1.5	0	1.5	0	0	0	0	0	1	0	0	1	0	0.5	0.5
66.01	20	3	0	1	1	1	6	0	3	0	0	2	0	0	3	3	0	11	1.5	0	1.5	0	0	0	0	0	1.5	0	0	1.5	0	0	0
66.02	38.5	3	0	1	1.5	0.5	6	3	3	3	3	3	3	3	3	3	0	27	0	3	3	0	0	0	0	0	1	0	0	1	1.5	0	1.5
67.01	39	3	0	1	1.5	0.5	6	3	3	1	1	2	1	3	3	3	3	23	1.5	3	4.5	0	0	1	0	1	1.5	0	0	1.5	1.5	1.5	3
67.02	22.5	3	0	0.5	1	0.5	5	2	3	0	0	0	0	0	1	3	0	9	1.5	3	4.5	0	1	0	0	1	0	0	0	0	1.5	1.5	3
67.03	24.5	3	0	0	1.5	0.5	5	1	2	0	0	2	0	1	1	3	0	10	1.5	3	4.5	1	1	1.5	0	3.5	1	0	0	1	0.5	0	0.5
67.04	25.5	2	2	0.5	0.5	1.5	6.5	1	1	0	1	2	0	3	2	3	3	16	0	0	0	0	2	0	1	3	0	0	0	0	0	0	0
67.05	25	2	2	0.5	0.5	1	6	2	1	0	2	1	1	2	1	2	3	15	0	1	1	0	1	1	1	3	0	0	0	0	0	0	0
69.01	29	3	3	0.5	0.5	1	8	1	1	0	1	3	0	2	1	2	3	14	1.5	2	3.5	0	1	0	1	2	0.5	0	0	0.5	1	0	1
70.01	15	3	0	1	0.5	0.5	5	0	2	0	2	0	0	1	0	3	0	8	1.5	0	1.5	0	0	0.5	0	0.5	0	0	0	0	0	0	0
71.01	17.5	0	3	1	0.5	1.5	6	0	0	0	1	3	0	3	0	0	0	7	1.5	3	4.5	0	0	0	0	0	0	0	0	0	0	0	0
76.01	17	0	1	0.5	0.5	1	3	1	2	0	1	1	0	1	1	2	0	9	1.5	2	3.5	0	0	0.5	1	1.5	0	0	0	0	0	0	0
79.01	26	3	0	1.5	1.5	0.5	6.5	2	3	0	2	3	1	1	1	3	0	16	0	3	3	0	0	0	0	0	0.5	0	0	0.5	0	0	0

Scores by Reach Using North Carolina Protocol

Site ID	Total Score	Riffle-pool Sequence	Substrate Sorting	Natural Levees	Sinuosity	Active or Relic Floodplain	Braided Channel	Recent Alluvial Deposits	Bankfull Bench Present	Continuous Bed and Bank	2nd Order of Greater Channel Present	Primary Geomorphology Score	Groundwater Flow/Discharge Present	Primary Hydrology Score	Fibrous Roots in Streambed	Rooted Plants in Streambed	Periphyton Present	Bivalves Present	Primary Biology Score	Head Cut Present in Channel	Grade Control Point in Channel	Topography Indicates Natural Drainage	Secondary Geomorphology Score	This Year's Leaflitter in Streambed	Sediment on Plants or Debris	Wrack Lines Present	Water in the Channel	Water in Channel During Dry Conditions	Hydric Soils in Sides of Channel	Secondary Hydrology Score	Fish	Amphibians	Aquatic Turtles	Crayfish	Macroinvertebrates	Iron Oxidizing Bacteria/Fungus	Filamentous Algae	Wetland Plants in Streambed	Secondary Biology Score
3.01	13.5	1	2	0	1	1	0	0	0	1	0	6	0	0	3	2	0	0	5	0	0.5	1	1.5	0.5	0.5	0	0	0	0	1	0	0	0	0	0	0	0	0	0
4.01	20	2	3	0	1	0	0	1	1	3	0	11	0	0	3	3	0	0	6	0	0	1.5	1.5	1	0	0.5	0	0	0	1.5	0	0	0	0	0	0	0	0	0
5.02	26	2	3	1	2	1	0	3	2	2	0	16	0	0	3	3	0	0	6	0	0.5	1.5	2	0.5	0	1.5	0	0	0	2	0	0	0	0	0	0	0	0	0
7.01	21	2	1	0	0	1	0	0	1	1	0	6	0	0	2	3	0	0	5	0	0	0	0	1	1.5	1.5	1.5	1.5	1.5	8.5	1.5	0	0	0	0	0	0	0	1.5
9.01	20	1	2	0	0	0	0	1	1	3	0	8	0	0	3	3	0	0	6	0	0	0	0	1	0.5	0.5	1.5	0	1.5	5	0	0	0	0	1	0	0	0	1
11.01	15	1	1	0	1	1	0	1	2	2	0	9	0	0	1	1	0	0	2	0	1	1.5	2.5	0	1	0.5	0	0	0	1.5	0	0	0	0	0	0	0	0	0
14.01	2.5	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1.5	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.01	2.5	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1.5	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.01	11.5	1	1	0	1	1	0	1	1	2	0	8	0	0	1	0	0	0	1	0	0	1	1	0.5	0	1	0	0	0	1.5	0	0	0	0	0	0	0	0	0
19.01	4	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0.5	0	1.5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20.02	9	0	0	0	0	0	0	0	0	1	0	1	0	0	3	3	0	0	6	0	0	1.5	1.5	0	0	0.5	0	0	0	0.5	0	0	0	0	0	0	0	0	0
21.02	22	0	0	0	1	2	2	1	0	1	0	7	3	3	2	1	0	0	3	0	0	1.5	1.5	1.5	0.5	0	1.5	1.5	1.5	6.5	0	0	0	0	0	1	0	0	1
23.01	5	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0	2	0.5	0	1.5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24.01	19	1	2	0	1	2	0	1	0	2	0	9	1	1	1	3	0	0	4	0	0	1.5	1.5	0.5	0.5	1	0.5	0	0	2.5	0	0	0	0	0	0.5	0	0.5	1
30.03	25.5	2	2	0	2	1	0	1	2	3	0	13	0	0	3	3	0	0	6	0	0.5	1	1.5	0.5	0	0.5	1.5	0	1.5	4	0	0	0	0	0	1	0	0	1
34.01	17	1	3	0	1	0	0	1	0	1	0	7	0	0	3	3	0	0	6	0	0	1.5	1.5	1	0.5	1	0	0	0	2.5	0	0	0	0	0	0	0	0	0
35.01	11.5	0	2	0	0	0	0	1	0	0	0	3	0	0	3	2	0	0	5	1	0	1	2	1	0.5	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0
38.03	22	1	1	0	1	1	0	1	2	2	0	9	1	1	2	2	0	0	4	1	1	1	3	0.5	0.5	0.5	0.5	0	1.5	3.5	0	0	0	0	0	1	0	0.5	1.5
38.05	25	2	2	0	1	2	0	1	1	2	0	11	2	2	2	2	0	0	4	0	0.5	1	1.5	0.5	0.5	0.5	1	0.5	1.5	4.5	0	0	0	0.5	0	1.5	0	0	2
39.01	12.5	0	3	0	1	0	0	0	0	1	0	5	0	0	3	3	0	0	6	0	0	0.5	0.5	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
40.01	20	0	2	0	1	2	1	2	1	2	0	11	1	1	2	1	0	0	3	0.5	0.5	1	2	1	0.5	1	0	0	0	2.5	0	0	0	0	0	0	0	0.5	0.5
40.02	23.5	1	2	0	1	1	0	1	2	2	0	10	2	2	2	2	0	0	4	0	1.5	1	2.5	1	0.5	1	1	0.5	0	4	0	0	0	0	0	0.5	0	0.5	1
42.01	20.5	2	2	0	1	0	1	0	1	3	0	10	3	3	1	3	0	0	4	0	0	0	0	1.5	0.5	0	1.5	0	0	3.5	0	0	0	0	0	0	0	0	0
49.01	19.5	1	2	0	0	2	1	2	0	3	0	11	0	0	1	3	0	0	4	0	0	0	0	0	0	1	1.5	0	1.5	4	0	0	0	0	0.5	0	0	0	0.5
51.01	17.5	2	2	0	1	2	1	1	0	3	0	12	0	0	2	1	0	0	3	0	1	0	1	0.5	0	1	0	0	0	1.5	0	0	0	0	0	0	0	0	0
52.01	9.5	0	1	0	0	0	0	1	1	1	0	4	0	0	3	0	0	0	3	0	0	0	0	0	1.5	1	0	0	0	2.5	0	0	0	0	0	0	0	0	0
52.02	17.5	0	3	0	0	1	1	2	0	3	0	10	0	0	0	3	0	0	3	0	1	0	1	0.5	0	1.5	0	0	1.5	3.5	0	0	0	0	0	0	0	0	0
53.01	23	2	1	0	2	1	0	2	2	3	0	13	0	0	2	3	0	0	5	0	1	1	2	0	0.5	0.5	1.5	0	0	2.5	0	0	0	0	0	0.5	0	0	0.5
54.02	14	0	0	0	2	2	0	0	1	3	0	8	0	0	3	2	0	0	5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55.01	10.5	0	0	0	1	0	2	1	0	1	0	5	0	0	2	0	0	0	2	0.5	0	1	1.5	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0
60.01	24	0	2	0	1	2	0	2	0	3	0	10	0	0	3	3	1	0	7	0	0	0	0	1.5	0	1.5	1.5	0	1.5	6	0	0	0	0	0.5	0	0.5	0	1
60.02	23	2	3	0	2	0	1	2	1	3	0	14	0	0	1	3	0	0	4	0	0	0	0	1	0	1.5	1.5	0	0	4	0.5	0	0	0	0	0.5	0	0	1
61.01	14	0	1	0	0	0	0	2	0	3	0	6	0	0	2	3	0	0	5	0	0	0	0	0	0	1.5	1.5	0	0	3	0	0	0	0	0	0	0	0	0
65.01	19	2	2	0	0	0	1	2	1	3	0	11	0	0	0	3	0	0	3	0	0	0	0	0.5	0	1.5	1.5	0	0	3.5	0	0.5	0	0	1	0	0	0	1.5
66.01	22.5	0	3	0	0	2	0	0	3	3	0	11	0	0	2	3	0	0	5	0	0	0	0	1	1	1	1.5	0	0	4.5	0	0	0	1	1	0	0	0	2
67.02	20.5	2	3	0	0	0	0	0	1	3	0	9	0	0	0	3	1	0	4	0	0	0	0	1	0.5	1	1.5	0	0	4	1.5	1.5	0	0	0	0	0.5	0	3.5
67.03	22	1	2	0	0	2	0	1	1	3	0	10	0	0	2	1	1	0	4	0	0	0	0	0	0.5	1.5	1.5	0	1.5	5	0.5	0	0	0	1	1.5	0	0	3
70.01	18	0	2	0	2	0	0	1	0	3	0	8	0	0	3	3	0	0	6	0	0	0	0	1	0.5	0.5	1.5	0	0	3.5	0	0	0	0	0	0.5	0	0	0.5
71.01	26	0	1	0	1	3	0	3	0	0	0	8	3	3	3	3	0	0	6	0	0	0.5	0.5	1	1.5	0.5	1.5	1.5	1.5	7.5	0	0	0	0	0	0	0	1	1
76.01	19.3	1	2	0	1	1	0	1	1	2	0	9	1	1	1	1	0	0	2	1	0.5	0.5	2	0.5	1	0.5	0.5	0	1.5	4	0	0	0	0	0	0.5	0	0.75	1.25

Appendix B – Fairfax County Protocol

Perennial Stream Field Identification Protocol
May 2003

This protocol defines procedures for making field determinations between perennial and intermittent streams. The protocol was developed to support fieldwork for the Fairfax County stream-mapping project. Several existing protocols were used to develop this protocol including:

- Virginia Chesapeake Bay Local Assistant Department's (CBLAD) "Very Rough Draft Guidance for Making Perennial vs. Intermittent Stream Determinations." December 2000.
- North Carolina Division of Water Quality's "Perennial Stream Reconnaissance Protocols" January 2000. Version 2.0. (http://h2o.enr.state.nc.us/ncwetlands/strmfrm.html)
- Williamsburg Environmental Group, Inc. "Qualitative Field Procedures for Perennial Stream Determinations." [unpublished manuscript] Corresponding Author: D.A. DeBerry.
- U.S. Corps of Engineers Branch Guidance Letter No 95-01: Identification of Intermittent versus Ephemeral Streams – Not Ditches. October 1994.

The determination between a perennial and intermittent stream is based on the combination of hydrological, physical and biological characteristics of the stream. Field indicators of these characteristics are classed as primary or secondary and ranked using a weighted, four-tiered scoring system similar to the current system developed by the North Carolina Division of Water Quality (NCDWQ). As discussed below, a stream reach is classified as perennial based on the overall score as well as supporting information such as long term flow monitoring, presence of certain aquatic organisms, or historic information.

DEFINITIONS

Perennial Stream – A body of water flowing in a natural or man-made channel year-round, except during periods of drought. The term "water body with perennial flow" includes perennial streams, estuaries, and tidal embayments. Lakes and ponds that form the source of a perennial stream, or through which the perennial stream flows, are a part of the perennial stream. Generally, the water table is located above the streambed for most of the year and groundwater is the primary source for stream flow. In the absence of pollution or other manmade disturbances, a perennial stream is capable of supporting aquatic life.

Intermittent Stream – A body of water flowing in a natural or man-made channel that contains water for only part of the year. During the dry season and periods of drought, these streams will not exhibit flow. Geomorphological characteristics are not well defined and are often inconspicuous. In the absence of external limiting factors (pollution, thermal modifications, etc), biology is scarce and adapted to the wet and dry conditions of the fluctuating water level.

DATA REVIEW

The following information should be reviewed prior to conducting a field reconnaissance.

- Existing Fairfax County GIS data layers for the generation of 1:250 scale field maps showing project area.
- USGS 7.5-minute quadrangle maps and current USDA Fairfax County Soil Survey.
- County aerial photographs.

- Current weather conditions including date of last rainfall and drought condition using the following sources of data:
  - ✓ Fairfax County-Department of Public Works and Environmental Services currently maintains 10 rain gauge stations within the County (see Appendix A for relative locations).
  - ✓ Dulles airport http://weather.noaa.gov/weather/current/KIAD.html
  - ✓ Regan National Airport http://weather.noaa.gov/weather/current/KDCA.html
  - ✓ Virginia State Climatology Office http://climate.virginia.edu/
  - ✓ Virginia DCR Drought Monitor: http://www.deq.state.va.us/info/drought.html
  - ✓ U.S. Drought Monitor http://www.drought.unl.edu/dm/index.html
  - ✓ The National Weather Service http://205.156.54.206/er/lwx/index.htm

FIELD RECONNAISSANCE

General Procedures

- The field protocol was developed for use throughout the year, with an expected amount of redundancy to account for seasonal variation. March through May represents the optimum time period to observe key biological species and normal flow conditions. The dry season (July through September) represents the ideal time to observe stream flow. Streams that contain flow during the dry period are likely to be perennial assuming normal precipitation conditions. However, the final determination of perenniality should be based on an evaluation of the hydrological, physical, and biological field indicators defined below.

- Preliminary stream reaches should be identified on the generated maps prior to field observations. The maps should include all pertinent GIS data layers including streams, roads, building footprints, parcels, parking lots, RPAs, topography, stormwater structures, sanitary sewer structures, etc.. By studying the maps before field investigations, more information can be ascertained about land uses and landscape characteristics in contributing drainage areas, as well as access issues and sampling logistics.

- Field reconnaissance should begin within the existing RPA or from the upstream point of flow to confirm the presence of a perennial stream. Proceed to a point where there is a significant change in the hydrological, geomorphological, or biological conditions of the stream. For example, a confluence with a flowing tributary. Document grade controls and headcuts on the 1:250-scale field map and on the field data sheet. Also document on the maps where flow begins and whether it is from a groundwater seep/spring or outfall. These features along with site scores and other reach characteristics will ultimately be used to determine the break point between perennial and intermittent stream reaches. It has been observed that flow may stop at a point and begin again some distance downstream. Therefore, reconnaissance should continue until obvious intermittent or ephemeral stream characteristics are noted (lack of strong evidence of continuous drainage channel, dry channel, etc.). After walking upstream and documenting the aforementioned features, investigators should then have a good idea where individual stream

***Figure 1**: Example of a headcut where perennial stream flow begins.*

reach breaks lie. At this point sampling reaches may be established and subsequent data sheets filled out.

- Complete a data sheet for each catchment. Determinations are made on a representative stream reach by examining at least 200 feet and not a single point. A reach should have similar physical characteristics and may be bounded by an upstream and downstream tributary, grade control, other physical feature (headcut, pipe, etc), or an obvious change in channel characteristic (sinuosity, slope, etc). The upper limits of a reach will define the upper limits of a perennial stream. Document the location of the reach and site ID on the field map and data sheet. See Appendix B for a list of feature and reach codes.

<u>Equipment</u>

- Camera
- 16 inch Oakfield probe or Dutch Auger
- Sharpshooter spade
- D-frame dip net/white sorting tray (optional, but may be necessary in Coastal Plains)
- Polarized sunglasses (optional)
- Munsell Soil Color Charts
- GIS-generated site maps (approximately 1 inch = 250 feet)
- Virginia Save Our Streams Benthic Macroinvertebrate Field Sheets: *http://www.sosva.com/download_the_field_sheets_for_th.htm*
- Vegetation Field Guides (Examples):
  Harlow, William M. *Trees of the Eastern and Central United States and Canada*. New York: Dover Publications, Inc., 1942.
  Hurley, Linda M. *Field Guide to the Submerged Aquatic Vegetation of Chesapeake Bay*. U.S. Fish and Wildlife Service, 1992.
  Magee, Dennis W. *Freshwater Wetlands, A Guide to Common Indicator Plants of the Northeast*. Amherst: The University of Massachusetts Press, 1981.
  Newcomb, Lawrence. *Newcomb's Wildflower Guide*. Boston: Little, Brown and Company, 1977.
  Petrides, George A. *Peterson Field Guides Series-A Field Guide to Trees and Shrubs, Northeastern and north-central United States and southeastern and south-central Canada*. Boston: Houghton Mifflin Company, 1958.
  Tiner, Ralph W. *Field Guide to Nontidal Wetland Identification*. Cooperative Publication. Annapolis: Maryland Department of Natural Resources; Newton Corner: U.S. Fish and Wildlife Service, 1998.

FIELD INDICATORS

When assessing the field indicators, in addition to the individual descriptions given below, the amount of time and effort involved in locating and identifying the features described must be factored into each ranking. Use the following time/effort guidelines in conjunction with the detailed ranking parameters for each indicator in assessing the strong, moderate, weak or absent description and assigning the associated scores. *Note*: "strong" does not always mean a strong indication of perenniality. Some indicators, such as leaflitter in streambed, will receive a score of zero for "strong".

Strong - Found easily and consistently throughout the reach.
Moderate - Found with little difficulty but not consistently throughout the reach.
Weak - Takes 10 or more minutes of extensive searching to find.
Absent - Indicator is not present.

Streamflow and Hydrology

1. **Presence or absence of flowing water, >48 hours since last rainfall:** Preferably, flow observations should be taken at least 48 hours after the last rainfall. Local weather data and drought information should be reviewed before evaluating flow conditions. See Data Review section, above, for weather data sources.

   Perennial streams will have water in their channels year-round in the absence of drought conditions. If a stream exhibits flowing water in the height of the dry season (mid-summer through early fall), then it probably conveys water perennially. On the other hand, a stream that does not exhibit flow during periods of increased rainfall would indicate an intermittent or ephemeral flow. Flow is more readily observed in the riffles and very shallow, higher-velocity areas of the stream. Dropping a floating object on the water surface will aid in determining if flow is present.

   Strong - Flow is highly evident throughout the reach. Moving water is easily seen in riffles and runs.
   Moderate - Moving water is easily seen in riffle areas but not as evident throughout the runs.
   Weak - Flow is barely discernable in areas of greatest gradient change (i.e. riffles) or floating object is necessary to observe flow.
   Absent - Water present but there is no flow; dry channel with or without standing pools.

2. **Presence of high groundwater table or seeps and springs:** Groundwater Table: The presence of a high groundwater table or discharge (i.e. seeps or springs) indicates a relatively reliable source of water to a nearby stream. Indicators of a high groundwater table include visual observation of inundation or soil saturation in the floodplain. Indicators of a high water table can be observed by digging a hole in the adjacent floodplain approximately two feet away from the streambed. The presence of water seeping into the hole (usually a slow process) or the presence of hydric soils indicates the presence of a high groundwater table. Use the *Munsell Soil Color Charts* book to determine the chroma of the soil matrix/mottles in the hole. Low chroma soils or mottled soils are good indicators of a high groundwater table*. Hydric soils in the sides of a channel or headcut are also indicators of groundwater discharge. High groundwater tables are commonly found in the Coastal Plain as well as portion of the Triassic Basin within areas with low relief. Seeps: Seeps have water dripping or slowly flowing out from the ground or from the side of a hill or incised stream bank. Springs: Look for "mushy" or very wet, and black decomposing leaf litter nearby in small depressions or natural drainage ways. Springs and seeps often are present at grade controls and headcuts. The presence of this indicator suggests that the stream is continually being recharged by a groundwater source unless during a period of drought. Score this category based on the abundance of these features observed within the reach.

   Strong - Spring, seep or groundwater table is readily observable throughout reach.
   Moderate - Springs, seeps or groundwater table are present, but not abundant throughout reach.
   Weak - Indicators are present, but require considerable time to locate.
   Absent - No springs or seeps present and no indication of a high groundwater table.

*For more information on chroma and redox-morphic features, see following geomorphology section.

3. **Leaflitter in streambed:** Are leaves (freshly fallen or older leaves that may be "blackish" in color and/or partially decomposed) accumulating in the streambed? Perennial streams (with deciduous riparian vegetation) should continuously transport plant material through the channel. Leaves and lighter debris will predominate throughout the length of non-perennial stream channels, whereas there will be little to no leaves present in the stronger flowing areas (riffles) with small accumulations on the upstream side of obstructions. This indicator may be hindered during autumn sampling in

between rain events. This is a secondary hydrologic indicator. *Note the reversal of score on the data sheet.*

Strong - Abundant amount of leaf litter is present throughout the length of the stream.
Moderate - Leaf litter is present throughout most of the stream's reach with some accumulation beginning on the upstream side of obstructions and in pools.
Weak - Leaf litter is present and is mostly located in small packs along the upstream side of obstructions and accumulated in pools.
Absent - Leaf litter is not present in the fast moving areas of the reach but there may be some present in the pools.

4. **Drift lines or wrack lines:** Twigs, sticks, logs, leaves, trash, plastics, and any other floating materials piled up on the upstream side of obstructions in the stream, on the streambank, in overhanging branches, and/or in the floodplain indicate high stream flows. Unless downstream of a stormdrain, non-perennial streams usually exhibit fewer or no drift lines within their channels. This is a secondary hydrologic indicator of perenniality.

   Strong - Large drift lines are prevalent along the upstream side of obstructions within the channel and the floodplain.
   Moderate - Large drift lines are dispersed mostly within the stream channel.
   Weak - Small drift lines are present within the stream channel.
   Absent - No drift lines are present.

5. **Sediment on debris or plants:** Are plants in the stream, on the streambank, or in the floodplain stained white, gray, red, or brown, with sediment? Look for silt/sand accumulating in thin layers on debris or rooted aquatic vegetation in the runs and pools. Be aware of upstream land-disturbing construction activities, which may contribute greater amounts of sediments to the stream channel, and can confound this indicator. Note these activities on the data sheet. This is a secondary hydrologic indicator.

   Strong - Sediment found readily on plants and debris within the stream channel, on the streambank, and within the floodplain throughout the length of the stream.
   Moderate - Sediment found on plants or debris within the stream channel although not prevalent along the stream. Mostly accumulating in pools.
   Weak - Sediment is isolated in small amounts along the stream.
   Absent - No sediment is present on plants or debris.

Geomorphology

1. **Riffle-Pool sequence**: A repeating sequence of riffle/pool (or riffle/run in lower-gradient streams) can be observed readily in perennial streams. This morphological feature is always present to some degree in higher gradient streams such as the piedmont streams that predominate much of Fairfax County. This is a result of sediment transport and the work of channel-shaping hydrologic forces. Riffle-Shallow, turbulent areas along narrower portions of a stream where the water has a tendency to churn and flow rapidly. In smaller streams, riffles are defined as areas of a distinct change in gradient where flowing water can be observed. Pool-Areas of slow moving water, where the stream widens and deepens. Along the stream reach, take notice of the frequency between the riffles and pools. Keep in mind that because of higher gradients, riffles are more frequent in the Piedmont physiographic province than in the Coastal Plains and many parts of the Triassic Basin.

   Strong - Demonstrated by an even and frequent number of riffles followed by pools along the entire reach. There is an obvious transition between riffles and pools.
   Moderate - Represented by a less frequent number of riffles and pools. Distinguishing the transition between riffles and pools is difficult.
   Weak - Streams show some flow but mostly have areas of pools or mostly areas of riffles.
   Absent - There is no sequence exhibited, or there is no flow in the channel.

2. **USDA Texture in stream bed/Substrate Sorting:** Observe the substrate comprising the bottom of the streambed. In pristine stream environments with a normal flow regime, substrate movement is highly dependent upon particle size; heavier substrate material (sands, gravel and cobbles) tends to remain in place while the finer silts and clays are transported quickly downstream. In urban and suburban areas, however, storm outfalls often drain runoff directly to the channel, and the highly erosive flash flows associated with heavy storm events remove all sized particles, and the channel quickly becomes incised. Although the distinction between the two situations should be kept in mind, the manner in which the remaining particles settle out will be consistent, and the question becomes, "is there an <u>even</u> distribution of various sized substrates throughout the reach or does partitioning occur (See Appendix C)?" The occurrence of depositional features will be infrequent in intermittent streams. Perennial streams, on the other hand, tend to exhibit correspondingly larger depositional features, with cobble/gravel/boulders being localized in riffles and runs, and with accumulations of fine sediments settling out in pools.

    Strong - There is a clear distribution of various sized substrates. Depositional features are present, finer particles are absent or accumulate in pools, and larger particles are located in the riffles/runs.
    Moderate - Various sized substrates are present but represented by a higher ratio of larger particles (cobble/gravel/rock). Small depositional features are present; small pools are accumulating some sediment.
    Weak - Substrate sorting is not readily observed. There may be some small depositional features present on the downstream side of obstructions (large rocks, etc…).
    Absent – Substrate sorting is absent. There are few depositional features.

3. **Natural levees**: Levees develop when sand or silt is deposited relatively parallel to the top of the bank. These aid in the concentration of water to the channel during periods of high flow. They are represented as large "mounds", "hills", or broad low "ridges" that may be covered by vegetation or remain as bare areas. Scoring is based on the presence and length of the levee through the stream reach.

4. **Sinuosity**: How much does the stream bend and curve? Is the channel meandering? Has the stream been straightened by human influence (i.e. piping, ditching, stormdrains, farming, roads, etc…). If so, is the stream beginning to meander around deposited sediments *within* its channelized banks? Sinuosity is the ratio of the stream channel length (SL) to the down-valley length (VL). The higher the ratio (SL/VL), the more sinuous the stream. Sinuosity is the result of the stream naturally dissipating its flow forces. Intermittent streams don't have a constant flow regime, and as a result exhibit a significantly less sinuous channel morphology. While ranking, take into consideration the size of the stream, which may also influence the stream wavelength. Sinuosity may be visually estimated, or approximated using a map and a map-wheel.

    Strong - Ratio > 1.4. Stream has numerous, closely-spaced bends, very few straight sections.
    Moderate - Ratio $\leq$ 1.4. Stream has good sinuosity with some straight sections.
    Weak - Ratio $\leq$ 1.2. Stream has very few bends and mostly straight sections.
    Absent - Ratio = 1.0. Stream is completely straight with no bends.

5. **Active (or Relic) Floodplain**: Floodplains are relatively flat areas usually located outside of or adjacent to the stream bank that accumulate organic matter and alluvium deposited during flooding. An active floodplain shows characteristics such as drift lines, sediment deposited on the banks or surrounding plants, which may also be flattened by flowing water. In cases of severe channel incision (down-cutting) the stream's new floodplain may be restricted to within the channel itself, and its disconnected (relic) floodplain will be harder to see (outside of channel). In these instances, look for

indicators along the sides and within the incised channel. In either case, there should be evidence of a floodplain if the stream has perennial flow.

Strong - The area displays all of the aforementioned characteristics.
Moderate - Most of the characteristics are apparent.
Weak - The floodplain is not obvious, however some of the indicators are present.
Absent - The characteristics are not present.

6. **Braided Channel**: Occurs in shallow, low gradient areas where abundant sediment has a tendency to build up, crosscutting the stream creating a braided pattern.
   Strong - The stream displays a braided appearance with many crossings creating many "islands".
   Moderate - The stream displays a braided pattern however, it does not cross many times and only has a few "islands".
   Weak - The braided pattern is present but the stream only crosses one or two times creating only one or two "islands".
   Absent - The gradient is too high such that the water is flowing too quickly in order to create a braided channel.

7. **Recent Alluvial Deposits:** Alluvium may be deposited as sand, silt, various sized cobble, and gravel. Observe whether or not there is any recent deposition or accumulation of these substrates within the stream channel (sand and point bars) or floodplain. The amount of alluvium deposited will indicate whether water is constantly pushing substrate downstream and will also determine ranking. Keep in mind that eroding stream channels influenced by stormwater drains/outfalls will likely score higher than natural channels for this indicator.
   Strong - Large amounts of sand, silt, cobble, and/or gravel alluvium present in the channel and in the floodplain.
   Moderate - Large to moderate amount of sand, silt, cobble, and/or gravel mostly present in the stream channel.
   Weak - Small amounts of sand, silt, and/or small cobble present within the channel.
   Absent - There is no sand or point bars present within the stream channel and no indication of overbank deposition within the floodplain.

8. **Bank-full Bench present:** When a stream channel conveys perennial flow, the forces of channel scouring and deposition create certain distinct physical features, which can be readily observed. One of these features includes scoured areas along the bank above which the stream banks are much less eroded. Another feature is accumulations sand or silt creating a bar or "bench" which may or may not be covered with vegetation. The former should be fairly continuous along the length of the stream's banks and should be seen at roughly the same elevation as the top of any sediment bars (where the stream bank slope begins to increase dramatically). Please see Figure 2 below.

Figure 2*: Examples of bank-full elevation (bench) in a second order, perennial stream.*

Bank-full indicators imply that the channel experiences a relatively continuous hydrologic regime and is in dynamic equilibrium with the shaping forces of its water/sediment load. The flow regime, soils and grade determine the bank-full width and morphology of the conveyance channel. The more obvious and continuous the bank-full features are throughout the reach, the higher the score should be.

Strong - Bank-full indicators are obvious throughout the sample reach.
Moderate - Indicators are present throughout most of the reach.
Weak - Indicators are infrequent along sampling reach.
Absent - Indications of a bank-full bench are completely lacking.

9. **Continuous bed and bank:** Throughout the length of the stream, is the channel well defined by having a clearly discernable bank and streambed? The clarity of this indicator lessens upstream as the stream becomes ephemeral.
   Strong - There is a continuous bed and bank throughout the length of the stream channel.
   Moderate - The majority of the stream has a continuous bed and bank. However, there are obvious interruptions.
   Weak - The majority of the stream has obvious interruptions in the continuity of bed and bank. However, there is still some representation of the bed and bank sequence.
   Absent - There is little or no ability to distinguish between the bed and bank.

10. **Second order or greater *channel*:** The higher the channel order the more likely the stream is to be perennial. Stream order should be based on available information and evaluated in the field. The primary map sources to be use include the Fairfax County Soil Survey and the most recent Fairfax County GIS hydrography data layer. Second order flowing streams are almost always perennial, while second order channels are usually in the intermittent/perennial zone. It is often difficult to evaluate stream order on channels starting at a stormwater outfall. Based on field observations, these channels are considered 1st order. However, a review of historic data such as the County Soil Survey may indicate that the order is greater.
    YES - One or more first order channels are draining into the stream above sampling reach.
    NO – There are no first order inputs above sampling reach.

Streambed Soils

The soils indicators described here were taken from the wetland delineation procedures set forth in the 1987 US Army COE Manual:

Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experimentation Station, Vicksburg, Miss.

Figure 3: *Iron oxidized mottling of a gleyed soil matrix.*

1. **Redox-morphic features:** Iron found in the matrix of soil continuously inundated with water cannot come in contact with the oxygen in the air and thus stays in the reduced ferrous (Fe^{2+}) valence state. This is seen as a grayish soil matrix. If the soil goes through a wetting/drying phase (as with intermittent or ephemeral streambeds), the iron will oxidize once in contact with atmospheric O_2 to form the ferric (Fe^{3+}) valence state. This is seen as the classic iron oxide or "rust" red color mottling within the matrix (see Figure 3). This is a redox-morphic feature. Use a Dutch auger or Oakfield probe to obtain a 12 to 14-inch deep core of the streambed soil. This may be impossible in some very rocky bottom streams. In this case try to bore in at an angle where the stream bank meets the substrate. If this fails, the soils indicators are not applicable (N/A) and should not be scored. Be sure to split the soil pedon apart in many places to look for these small pockets of oxidized soil iron. Sometimes "oxidized rhizospheres" or higher colored mottles surrounding root cavities in the soil will be easily observed. Tiny (<2 mm), hard manganese or iron concretions in the matrix are also redox-morphic features. In inundated soils and wetlands, redox-morphic features are absent. Redox-morphic features are usually absent, or very difficult to observe in high chroma soils. However, the absence of redox features in these soils is not an indicator of inundation. Caution must be used when scoring this indicator in non-gleyed soils. In sandy soils, redox-morphic features are uncommon or very difficult to identify. In these instances look for organic matter distributed evenly throughout the matrix. Organic matter is moved downward through sandy soils as the water table fluctuates. As a result, dark organic streaks can be seen in most ephemeral and intermittent stream soils, which contain substantial amounts of organic materials. When soil from a darker area is rubbed between the fingers, the organic matter will leave a stain.

Scoring is ranked purely on the presence or absence of these features.

2. **Chroma:** Mineral soils which are exposed to atmospheric oxygen in the soil profile will have some degree of oxidation occurring and as a result will have bright red, orange, or yellow matrix colors (See Figure 4). Saturated soils, such as those found in the streambeds of perennial streams, have limited or no contact with O_2, will remain reduced and subsequently have a very dull color chroma or may be gleyed completely (dull gray hues or chroma throughout soil ped). See Figure 5. The soil sample should be representative of the major stream bed/bank soil type observed throughout the sample reach. Use the Munsell Color Charts book to determine the chroma of the soil matrix. The soil matrix is defined as the dominant soil constituent (>50%). Low chroma values (<2) or gleyed soils indicate continual saturation, while brightly colored soils or mottles (>2) indicate only short periods of wetting, typical of intermittent or ephemeral streambed soils or upland soils.

Figure 4: *A high chroma soil matrix*

Figure 5: *Completely gleyed, low-chroma soil matrix.*

Strong - Gleyed soils
Moderate - Matrix chroma of 1.
Weak - Matrix chroma of 2.
Absent - Matrix chroma of 2 or greater.

Vegetation

When ranking the presence of rooted aquatic plants in channel, periphython/green algae and iron oxidizing bacteria/fungus use the following:

Strong - Found easily and consistently throughout the reach.
Moderate - Found with little difficulty but not consistently throughout the reach.
Weak - Takes 10 or more minutes of extensive searching to find.
Absent - Indicator is not present.

1. **Rooted AQUATIC plants in channel:** Aquatic plants rooted in the substrate can be described as SAV and floating leaved plants. Some of the most common found are Water Lilies (*Nymphaeaceae*). Use wetland plant/aquatic plants field identification guides for appropriate designations.

2. **Presence of Periphyton/Green Algae:** These forms of algae and aquatic mosses are attached to the substrate, and are visible as a pigmented mass or film, or sometimes hairlike growths on submerged surfaces of rocks, logs, plants and any other structure within the stream channel. These life forms require an aquatic environment to persist. Periphyton growth is influenced by chemical disturbances such as increased nutrient (N and P) inputs and physical disturbances such as increased sunlight to the stream from riparian zone disturbances.

3. **Iron Oxidizing Bacteria/Fungus:** Iron oxidizing bacteria/fungus in streams derives energy by oxidizing iron, originating from groundwater, in the ferrous form (Fe^{2+}) to the ferric form (Fe^{3+}). In large amounts, iron-oxidizing bacteria/fungus discolors the stream substrate giving it a red appearance. In small amounts, it can be observed as an oily sheen on the water's surface. This indicates that the stream is being recharged from a groundwater source, and these features are most commonly seen at seeps or springs.

4. **Wetland plants in streambed:**
The U.S. Army Corp of Engineers wetland delineation procedure utilizes a plant species classification system upon which soil moisture regimes can be inferred. This same system can be used to determine the duration of soil saturation in streams. All wetland designations are defined by *1988 National List of Vascular Plant Species That Occur in Wetlands*, U.S. Fish and Wildlife Service.** Perennial indicator scores (0 through 3) corresponding to each class of vegetation are listed on field data sheet

SAV - (Submerged Aquatic Vegetation) grows completely underwater.
Example: Coontail (*Ceratophyllum demersum*)
Mostly OBL - Obligate wetland plants are almost always found in a wetland (estimated probability is greater than 99 percent) and any EAV (Emergent Aquatic Vegetation)
Examples: Skunk Cabbage (*Symplocarpus foetidus*), Cattail (*Typha spp.*)
Mostly FACW - Facultative wetland plants are mostly found in wetlands (estimated probability is 67 to 99 percent).
Example: Cardinal flower (*Lobelia cardinalis*)
Mostly FAC - Facultative plants are equally likely to occur in wetlands or non-wetlands (estimated probability is 34 to 66 percent).
Example: Southern Lady Fern (*Athryium felix-femina*)
Mostly FACU (1 to 33% probability), UPL (0 – 1% probability), or no plants in streambed.

**Reed, Jr., Porter B. 1988. National List of Plant Species That Occur in Wetlands: National Summary. U.S. Fish & Wildlife Service. Biol. Rep. 88 (24). 244 pp.

Has been updated to 1996 National Listing (1998 revision still pending approval). Available at http://www.nwi.fws.gov/bha

USDA/NRCS 1994 synonymized checklist - PLANTS database:
Available at http://plants.usda.gov/index.html

<u>Benthic Macroinvertebrates</u>

When checking for the presence or absence of Benthic Macroinvertebrates, clams and crayfish, follow these procedures based on physiographic province.

Turn over the rocks and other large substrate found in areas of visible flowing water, (i.e. riffles) and scan the undersides for benthic macroinvertebrates. Also observe the newly disturbed area where the rock once was for signs of movement. This method may be more suitable for the Piedmont and Triassic Basin provinces where riffles predominate. For the lower gradient Coastal Plain and other areas of slow moving water, benthic macroinvertebrates may be located in a variety of habitats including root wads, undercut banks, pools, leaf-packs, and submerged aquatic vegetation (SAV). Note that some benthic macroinvertebrates will make small debris/sand cases, which can be covered with periphyton and easily confused for excess debris picked up from the substrate.

All macroinvertebrates should be identified to order, using the Virginia Isaac Walton League Save Our Streams Bug ID Charts, available at http://www.sosva.com/download_the_field_sheets_for_th.htm. For Ephemeroptera, Plecoptera, and Trichoptera (EPT), samples should be identified to the lowest taxonomic level possible and noted on the back of the field data sheet. Samples can be retained for further analysis in the laboratory. If clams, crayfish or amphibians are found in the sample then also fill out the respective lines on the datasheet. Several samples should be taken to accurately assess the reach's benthic community.

When ranking the presence of benthic macroinvertebrates and bivalves, use the following:

Strong - Indicator is easily found in all samples.
Moderate - Only takes a few samples to locate indicator.
Weak - Sampling takes 10 minutes or more to locate indicator.
Absent - Indicator is not present.

1. **Benthic Macroinvertebrates:** The larval stages of most aquatic insects are good indicators that the stream is perennial because they require a continuous aquatic habitat until maturity. Crayfish and other crustaceans, as well as aquatic worms and snails are also included under this indicator. The existence of crayfish can also be detected by the presence of "crayfish chimneys" (an extruded tunnel of clay) seen on the stream banks. Follow the sampling/identification procedures detailed above. When scoring, take note of the <u>quantity as well as the diversity</u> of your macroinvertebrate sample. Because some of the species observed are not strict indicators of a constant aquatic regime, this is a secondary indicator of perenniality.

2. **Bivalves:** Clams require a constant aquatic environment in order to survive. Incorporate the search for bivalves while looking for other benthic macroinvertebrates. This indicator also includes any empty shells found on stream banks and within the channel.

3. **Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxa:** The larval stages of many species of these three orders require a period of at least a year, submerged in a constantly flowing aquatic environment before reaching maturity and therefore are commonly associated with perennial streams. Studies conducted by North Carolina State University have found that benthic samples collected in intermittent streams frequently display crustaceans (crayfish, isopods, and amphipods) as the dominant order. Downstream, where the stream has perennial characteristics, EPT taxa were collected. In highly urbanized areas, these indicators may be absent due to the degraded nature of the stream and, therefore, cannot be used to evaluate perennial or intermittent flow conditions. North Carolina State University is continuing to work on a list of specific genus that exhibit aquatic larval stages requiring a year before maturity. West Virginia's Department of Environmental Protection also maintains a list of macroinvertebrate species that have an extended aquatic life stage. These lists

should be consulted (family or genus level ID) before applying points to the reach score, because some genus, such as the baetis mayflies for example, are very ephemeral in their aquatic life stages.

Presence/Absence

Vertebrates

When ranking the presence of all vertebrates, use the following:

Strong - Indicator is readily visible in all prime habitats.
Moderate - Indicator is evident in smaller numbers. Some prime habitat is not occupied.
Weak - Indicator is not readily visible, requires 10 or more minutes to locate. Very sparse.
Absent - Indicator is not found.

1. **Fish:** The drastically fluctuating water levels of intermittent streams provide unstable and stressful habitat conditions for fish communities. Only a small number of species will opportunistically inhabit available areas within intermittent streams. Therefore, the presence of fish is used as a secondary indicator of perenniality. When looking for fish, all available habitats should be observed, including pools, riffles, root clumps, and other obstructions (to greatly reduce surface glare, the use of polarized sunglasses is recommended). In small streams, the majority of species usually inhabit pools and runs. Fish should be easily observed within a minute or two. Also, fish will seek cover once alerted to your presence, so be sure to look for them slightly ahead of where you are walking along the stream. Again, check several areas along stream sampling reach.

2. **Amphibians:** Newts, frogs, salamanders and tadpoles can be found under rocks, on streambanks and on the bottom of the stream channel. They may also appear in the benthic sample. Frogs will alert you of their presence by jumping into the water for cover, usually following an audible "squeak". Frogs and tadpoles typically inhabit the shallow, slower moving waters of the pools and near the sides of the bank. Amphibian eggs, also included as a minor indicator, can be located on the bottom of rocks and in or on other submerged debris. They are usually observed in gelatinous clumps or strings of eggs. Frog eggs will be much more prevalent in the springtime. Identify the species of amphibian or describe in detail the characteristics observed. A persistent water regime is not an exclusive requirement for all amphibious species, therefore this is a secondary indicator of perenniality.

Overall Score Interpretation

The final determination of whether a stream reach is perennial is based on a preponderance of information including the total score, supporting information and professional judgment. Based on the results of the pilot survey conducted in the Fall of 2001 and Spring 2002, a minimum total score of 25 was set as a guideline for classifying a stream as perennial. Higher scores indicate that a channel has more perennial characteristics. Streams with lower scores can be classified as perennial; however, other supporting information such as biological indicators should be used in making the final determination.

The total score can be affected by seasonal or hydrologic conditions as well as man-made impacts associated with activities in the watershed. For example, a reach may score less in drought conditions due to the lack of biological and/or certain hydrologic indicators. However, a reach may score higher on certain indicators, such as drift lines and alluvial deposits, if directly below a stormwater outfall. The final determination of perenniality must take these factors into account. If a stream is recognized as borderline, reaches upstream and downstream should be assessed to better evaluate the changes in stream classifications along a channel. Additional supporting information can be used with the total score to make the final determination. This supporting information includes:

Observation of flow: Observation of flow under certain seasonal or hydrologic conditions can directly support classifying a stream reach as intermittent or perennial.

Conditions supporting a perennial stream classification include:

- Stream reaches with flow during the dry season (July through September) or periods of drought are likely perennial. The longer the period from the last rainfall the stronger the presence of flow supports the perennial stream determination. Although the presence of flow during a drought indicates perennial conditions, care must be taken in evaluating the upper limits of perenniality because some perennial streams may only contain isolated pools of water or be dry during periods of drought.

Key biological indicators: As discussed under the biological criteria, the presence of aquatic organisms whose life cycle requires residency in flowing water for extended periods (especially those one year or greater) is a strong indication that a stream reach is perennial. A qualified aquatic biologist/environmental scientist should evaluate the presence and abundance of such macroinvertebrates and vertebrates species before determining the final stream classification.

Other supporting information: Other data to be considered in determining the final stream classification includes:

- Information provided by a long-term resident and/or local professional who has observed the stream during the various seasons and hydrologic conditions.
- Review of historic information such as aerial photography or the Fairfax County Soil Survey. Based on the pilot field surveys and initial countywide surveys, many of the streams shown as perennial (solid lines) on the County Soil Survey have been determined to be perennial using the field protocol.

Professional judgment should be used in conjunctions with the total score and supporting information in making the final determination.

Site ID:	Total Score:

Date:______________ Recorder: ____________________

Time:______________ Evaluators: ____________________

Field Indicators:

I.) Streamflow and Hydrology	Absent	Weak	Moderate	Strong
1.) Presence or absence of flowing water and > 48 hrs since last rainfall	0	1	2	3
2.) Presence of high groundwater table or seeps and springs	0	1	2	3
3.) Leaflitter in streambed	1.5	1	0.5	0
4.) Drift lines	0	0.5	1	1.5
5.) Sediment on debris or plants	0	0.5	1	1.5

Total Streamflow and Hydrology Points: ________

II.) Geomorphology	Absent	Weak	Moderate	Strong
1.) Riffle-pool sequence	0	1	2	3
2.) Substrate Sorting (USDA texture in streambed)	0	1	2	3
3.) Natural Levees	0	1	2	3
4.) Sinuosity	0	1	2	3
5.) Active or Relic Floodplain	0	1	2	3
6.) Braided Channel	0	1	2	3
7.) Recent Alluvial Deposits	0	1	2	3
8.) Bankfull Bench present	0	1	2	3
9.) Continuous Bed and Bank	0	1	2	3
10.) 2nd order or greater **channel** present	***Yes*** = 3		***No*** = 0	

Total Geomorphology Points: ______

III.) Streambed Soils				
1.) Redoximorphic features present in sides of channel or head cut.	***Present*** = 0		***Absent*** = 1.5	
2.) Chroma	gleyed = 3	1 = 2	2 = 1	> 2 = 0

Total Streambed Soils Points: ______

IV.) Vegetation	Absent	Weak	Moderate	Strong
1.) Rooted AQUATIC Plants in Streambed	0	1	2	3
2.) Presence of Periphyton/green algae	0	1	2	3
3.) Iron Oxidizing Bacteria/Fungus	0	0.5	1	1.5
4.) Wetland Plants in Streambed (Skip if no plants present in streambed)				
SAV = 3	Mostly OBL = 1.5	Mostly FACW = 1	Mostly FAC = 0.5	Mostly FACU, UPL, or None = 0

Total Vegetation Points: ______

Comments:

Front Page Total ________ points

V.) Benthic Macroinvertebrates	Absent	Weak	Moderate	Strong
1.) Benthic Macroinvertebrates	0	0.5	1	1.5
2.) Bivalves	0	1	2	3
3.) EPT taxa	***Present*** = 3			***Absent*** = 0

Total Benthic Macroinvertebrates Points: ______

VI.) Vertebrates	Absent	Weak	Moderate	Strong
1.) Fish	0	0.5	1	1.5
2.) Amphibians	0	0.5	1	1.5

Total Vertebrates Points: ______

Total Score:

Benthics/Amphibians Found:

Weather

Rain Gauge_______________ Date of Last Rainfall_________________ Rainfall Amount_________________

Reach Description

Upstream: TRB HCT GRC RCU POF SDO ARB RPA Other: ____________________

Downstream: TRB HCT GRC RCU POF SDO ARB RPA Other: ____________________

Comments:

Storm Network Connections and Watershed Observations

Riparian Buffers Width

LB: Distance >25 feet 26-50 51-75 76-100 100+

Cover type: Tree Shrub Herbaceous Lawn Other:

Dominant Species:

RB: Distance >25 feet 26-50 51-75 76-100 100+

Cover type: Tree Shrub Herbaceous Lawn Other:

Dominant Species:

Riparian Buffer Comments

Other Observations and Comments:

Is the reach perennial? **YES** **NO**

Photo #	Direction (US, DS, LB, RB)	Notes

Appendix C – North Carolina Protocol

INTERNAL GUIDANCE MANUAL

N.C. DIVISION OF WATER QUALITY STREAM CLASSIFICATION METHOD

January 19, 1999
Version 2.0

Introduction

This stream evaluation method is intended to distinguish ephemeral channels from intermittent channels. The numerical rating system format was developed based on repeated requests from the regulated community for an objective method of stream evaluation. The 19 point minimum score for determining an intermittent channel was based on the results of over 300 individual field trials conducted in the Piedmont and Coastal Plain portions of the Neuse River Basin during May, June, July and August of 1998, as well as field testing conducted during December 1998 and January 1999. The four tiered weighted scale used for this system is in response to the intrinsic variability of stream channels. The score ranges were developed in order to better assess the often gradual (and sometime variable) transition of streams from ephemeral to intermittent.

Previous versions of this form used a “yes”/ “no” format and was found by NCDWQ staff and by the regulated community to be inadequate to properly encompass and assess the natural variability encountered when making stream determinations in the field. Moderate characters are intended as an approximate qualitative midpoint between the two extremes of Absent and Strong. The remaining qualitative description of Weak represents gradations that will often be observed in the field. The “in between grades” are intended to allow the evaluator the required flexibility in assessing inherently variable features. In addition, the small increments in scoring between gradations will help reduce the range in scores between different evaluators.

How To Use The Classification

I. The Classification Form

The four tiered weighted scale is designed to encompass the range in variability of each character likely to be observed in the field. The Primary and Secondary indicators are weighted to reflect the relative importance that each character has in determining Intermittent channels from Ephemeral channels. Absent, Weak, Moderate, and Strong are defined below. **These definitions are intended as guidelines**. Personal experience and best professional judgement should also be employed in conjunction with these guidelines when evaluating streams. The evaluator must select the most appropriate number for each variable—selection between those in the form is not allowed.

Absent: The character is not observed. (On a scale of 1 to 10, Absent = 0)

Weak: The character is present but you have to search intensely (i.e., ten or more minutes) to find it. (On a scale of 1 to 10, Weak =1, 2, or 3).

Moderate: The character is present and observable with mild (i.e., one or two minutes) searching. (On a scale of 1 to 10, Moderate = 4, 5, or 6).

Strong: The character is easily observable. (On a scale of 1 to 10, Strong = 7 to 10).

Examples:

*(**These are intended as guidelines and the numbers given are provided only for a general reference. The numbers* ***should not necessarily*** *be taken literally**).*

Fish: *Absent*: No fish, even after an intense 10 minute search of a large (e.g., 200') liner stretch of stream. Fish sampling should be conducted visually and with a dip net.
Fish *Weak:* One or two fish found after an intense search.
Fish *Moderate*: After a mildly intensive search (i.e., 1 or 2 minutes), you see four or five individual fish, **or** one small school.
Fish: *Strong*: Upon casual observation, you see a half dozen fish **and/or** two or three small schools.

Meanders: *Absent*: The stream is straight.
Meanders: *Weak*: Nearly all of the stream is straight, only one or two very small bends.
Meanders: *Moderate*: Most of the stream is straight although there are a few bends. One or two of these bends may be large.
Meanders: *Strong*: Large portions of the stream bend. The bends will mostly be large or exaggerated.

II. Field Use Of The Classification System

A. Channel Assessment Methodology

Streams are drainage features that change from ephemeral to intermittent to perennial along a gradient or continuum—often times with no single distinct point demarcating these transitions. In order to determine ephemeral streams from intermittent ones using this classification system, the field evaluator must exercise caution. Determinations must not be made at one point without first walking up and down the channel. This initial examination allows the evaluator to examine and study the nature of the channel, make judgements about what is happening in the watershed, and make mental notes (based on the characters used in the classification form) about where along the reach in question the channel likely changes from ephemeral to intermittent. As a general rule of thumb, several hundred feet (sometimes much more) of channel should be walked to make these determinations. It is not possible to make decisions regarding ephemeral versus intermittent from evaluating a single point along the channel.

B. Addressing Weather Induced Variability

As channels convey water, their rate and duration of flow is influenced by recent and long-term weather. In order to "filter" out some of this variability, it is ***STRONGLY*** recommended that field evaluations be conducted at least 48 hours after the last known rainfall. However, please note that the classification method has been designed with enough built in redundancy to allow for reasonably accurate ratings even after a recent rainfall.

Primary Indicators

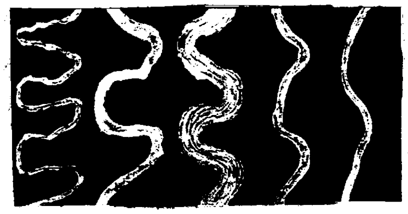
I. Geomorphology

#1 Riffle-Pool Sequence. Pools: Areas of slow moving water. These usually form where the stream widens. Riffles: Shallow areas extending across the streambed where the water moves faster. Usually these areas occur when the stream narrows. Sometimes this faster moving water runs over small rocks, cobble or pebbles (although rocks aren't always needed for a riffle).

#2 USDA Texture In Streambed: Is the material comprising the bottom of the stream different than the material comprising the surface of the ground surrounding the stream? (For example: Are there small pebbles, gravel or sand in the stream whereas the surrounding land is covered with leaves or topsoil, etc.)?

#3 Natural Levees: Are there large “mounds”, “hills”, or broad low “ridges” of sand or silt deposited parallel (or nearly so) to the stream on its floodplain and adjacent to one or both of its banks? These features may be covered with trees and shrubs or they may be barren sand or silt.

#4 Sinuosity: Does the stream bend? Are there curves in the stream? These bends or curves can be small or large. More formally, sinuosity is the ratio of the length of the channel to the down valley distance (i.e., 1:1 = straight channel).



#5 Active (Or Relic) Floodplain: A flat (or nearly flat) lowland that borders a stream, is covered by its waters at flood stage, and is built of organic matter and/or alluvium due to overbank deposition. These areas may have plants adapted to wet areas growing on them. Small floodplains can be found “inside” the stream’s banks in deeply incised channels. More frequently, floodplains are outside of the stream’s banks.

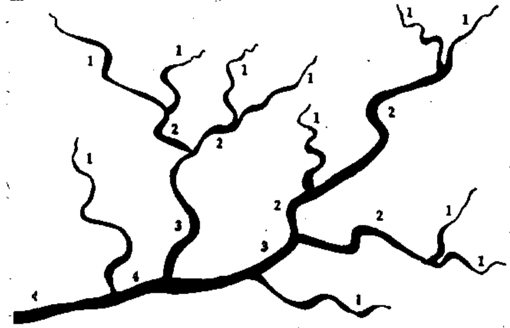
#6 Braided Channels: Are there more than one small stream channels that cross or “braid” over one another. This usually occurs in areas where the land flattens significantly and where there is abundant sediment supply in a wide streambed with shallow water flow.

#7 Recent Alluvial Deposits: Are there recent deposits or accumulations (in the stream or on adjacent floodplains) of sand, silt, cobble, or gravel?

#8 Bankful Bench: When you look at the side of the streambank is there a nearly continuous “bench” eroded into the channel which has accumulated sand or silt. This area is often covered with plants. In dry times when the stream is low, you can often see it part way up the bank. In wet times you may not be able to see it as the stream will be flowing over the bench.

#9 Bed And Bank: Is the water in the stream in a well-defined channel surrounded or “contained” by a higher bank area. In small streams the bank may be very low (sometimes only a few inches) and may not necessarily be a continuous feature.

#10 2nd Order Or Greater Channel: To your knowledge (you can look at SCS County Soils Survey Maps or U.S. Geological Survey Maps, or use field observations) is the channel that you are looking at have one (or more) other channels flowing into it?



Primary Indicators

II. Hydrology

#1 Ground Water: Seeps: Usually seeps have water dripping or slowly flowing out from the ground or from the side of a hill. Water Table: If you dig a hole in the ground near the stream (not in the streambed) of approximately a foot deep and water fills it (usually this will be a slow process) the water table is high and may help keep the stream flowing in dry seasons. High water tables are most common in the Coastal Plain.

Primary Indicators

Biology

#1 Fibrous Roots: When you look in the bottom (or edge) of the stream, are there very small (almost "hair-like") roots there? Fibrous roots do not include roots larger than half the thickness of a finger and are not generally "woody" in appearance or consistency.

#2 Rooted Plants In Streambed: Are there plants growing in the **bed** of the stream? Plants growing on any part of the bank of the stream should not be counted.

#3 Periphyton: When you look on rocks, logs, plants, or twigs in the water is there a "slimy" or "spongy-leafy" growth of algae or very small plants present? Usually the color is a brown-green or dark brown, although this growth can take on the color of the silt or sediment present in the stream.

#4 Bivalves: Are there clams or mussels in the stream? To look for them, dig around in the streambed or look for them where plants are growing in the streambed. Also, look for empty shells washed up on the bank. Some bivlaves (e.g., Fingernail clams) can be pea-sized or smaller.

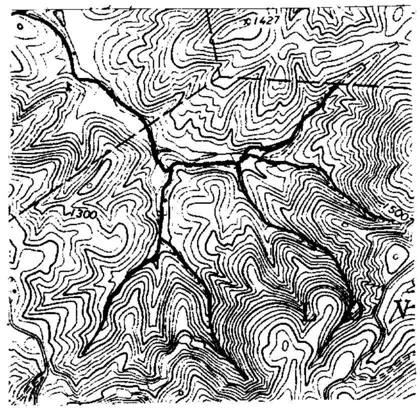
Secondary Indicators

I. Geomorphology

#1 Head Cut: An abrupt vertical drop in the bed of a stream channel. It often resembles a small intermittent waterfall (or a miniature cliff). Intermittent streams sometime start at these areas.

#2 Grade Control Point: Often this feature is distinguished by a large rock outcrop in the channel or by a large root which extends across the channel. These structures separate an abrupt change in grade of the stream bed.

#3 Topography Indicating A Natural Drainage Way?: When looking at the local topography in the field (or on a U.S. Geological Survey Map) does the land slope towards the channel (or are the contour lines fairly close together and roughly sinuous in shape and thereby indicating a "draw"?). In other words, does the land have slopes that seem to drain to or indicate a natural drainage way?



Secondary Indicators

II. Hydrology

#1 This (Or Last's) Years Leaflitter Present In Streambed: Are there leaves (freshly fallen, or some may be "blackish" in color and/or partially decomposed) present in the streambed?

#2 Sediment On Plants (Or Debris): Are plants (or rocks, logs, or other debris) in the stream (or on the streambank or flood plain) stained white, gray, red, brown, or reddish-brown with sediment?

#3 Wrack Lines: Are twigs, sticks, logs, leaves, or other floating material (including litter such as plastic soda bottles, beer cans, styrofoam, etc.) piled up on the upstream side of obstructions in the stream, on the streambank, and/or in the floodplain?

#4 Water In Channel >48 Hrs. Since Last Known Rainfall: Intermittent streams do not always have water in them. Water in intermittent channels may linger in pools or holes in the streambed. A good rule of thumb for distinguishing intermittent streams from ephemeral ones is if they have water in them for more than 48 hours since the last rain.

#5 Water In Channel During Dry Conditions Or In growing Season? Intermittent streams do not always have water in them. Look for water in pool areas or in holes in the streambed. Another good rule of thumb for differentiating ephemeral streams from intermittent ones is if they have water in them during dry (drought) conditions or during the growing season.

#6 Hydric Soils In Sides Of Channel (Or In Headcut): Are hydric soils present in the sides of the channel or in the headcut? Use a soil auger to sample these areas for hydric soil indicators.

Secondary Indicators

III. Biology

#1 Are Fish Present: Look for fish in pools or other areas of standing water in the stream. In addition, look under overhangs in the bank, near tree roots, on the downstream side of rocks or other large obstructions, or in and around plants.

#2 Are Amphibians Present: Look for frogs near the bank and in the water (also look for tadpoles in the water). Salamanders may also be found under rocks, logs, or leaf packs in the stream or in very moist leaf litter, moss, or logs (and under rocks) next to the stream.

#3 Are Aquatic Turtles Present: Look for turtles on rocks or logs in the stream or in and around rocks and logs in areas adjacent to the stream. Also look for turtles basking in areas exposed to sunlight.

#4 Crayfish: Look for crayfish in small pools, under rocks, under logs, sticks or within leaf packs in the stream. Additionally, look for small holes in the muddy streambank or look for distinct “chimneys” (roughly cylindrical chimneys) on the muddy bank.

#5 Macrobenthos: Look under rocks, logs, twigs, and leaf packs. Also look under the streambank and in (and on) any vegetation in the stream. If you have a dip net, drag it around the streambank and in any vegetation or leaf packs present. If you have a kick net set it up downstream of any riffles and kick (and “wash”) the rocks in the riffle so that the material disturbed is caught in the downstream net. The use of nets for this step is strongly recommended.

#6 Iron Oxidizing Bacteria/Fungus: In slow moving (or stagnant) areas of the stream are there clumps of “fluffy” rust-red material in the water? Additionally, on the sides of the bank (or in the streambed) are there red or rust colored stains (usually an “oily sheen” or “oily scum” will accompany these areas) on the soil surface? These features are often (although not exclusively) associated with groundwater.

#7 Filamentous Algae: In slow moving areas (or in pools or stagnant areas) are floating green algae (usually not attached to rocks or logs) present?

#8 Wetland Plants In Streambed: Are plants usually associated with wet areas present in the streambed? For example, cattails or black willow? (For determining OBL, FACW, FAC, FACU, or UPL **See Appendix I)** . Submerged aquatic vegetation (SAV) includes rooted plants that generally grow totally submerged under the water’s surface.

NCDWQ Stream Classification Form

Project Name:	River Basin:	County:	Evaluator:
DWQ Project Number:	Nearest Named Stream:	Latitude:	Signature:
Date:	USGS QUAD:	Longitude:	Location/Directions:

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present? *(*NOTE: If Bed & Bank Caused By Ditching And **WITHOUT** Sinuosity Then Score=0*)*	0	1	2	3
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map ***And/Or*** In Field) Present?	***Yes***=3		***No***=0	

PRIMARY GEOMORPHOLOGY INDICATOR POINTS:______

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS:______

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS:_______

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS:______

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaflitter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel ***And*** >48 Hrs. Since Last ***Known*** Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions ***Or*** In Growing Season)?	0	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?	***Yes****=1.5*		***No***=0	__

SECONDARY HYDROLOGY INDICATOR POINTS:______

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed?	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(**NOTE:** If Total Absence Of All Plants In Streambed As Noted Above Skip This Step **UNLESS** SAV Present*).*	*2*	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS:______

TOTAL POINTS (Primary + Secondary)=____(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)